109

20161/B

John Orr Ewing.

3/6

Richard J. Stevens

74288

ELEMENTS

OF

CHEMISTRY.

BY

JOSEPH FRANCIS JACQUIN,

PROFESSOR OF CHEMISTRY AND BOTANY AT VIENNA;
FELLOW OF THE LINNEAN SOCIETY AT LONDON;
AND MEMBER OF SEVERAL ACADEMIES OF
SCIENCE, AGRICULTURE, &c.

> Non figendum aut excogitandum, sed inveniendum quid natura ferat vel faciat.
>
> BACO.

THE THIRD EDITION.

TRANSLATED FROM THE GERMAN.

London:
PRINTED FOR THOMAS OSTELL, NO. 3, AVE MARIA LANE,
PATERNOSTER-ROW.

1803.

To

Mr E. Causer
from his friend

Ja. Balloch.—

WELLCOME
HISTORICAL
MEDICAL
LIBRARY

J. Cundee, Printer,
Ivy-Lane.

MR. JACQUIN wrote theſe Elements with a view to convey to the young ſtudent a knowledge of the moſt important truths in chemiſtry. The work, on its publication, met with a very favorable reception, and a copy of it having fallen into my hands, and being pleaſed with the accuracy and ſimplicity by which it is ſo eminently diſtinguiſhed, I thought it might be beneficial to the public to tranſlate it into Engliſh. In acquitting myſelf of this taſk, I have paid that ſcrupulous attention to accuracy, ſo eſſential in works of ſcience.

HENRY STUTZER.

Digitized by the Internet Archive
in 2016

https://archive.org/details/b22034808

CONTENTS.

Page
INTRODUCTION 1
I. *Of chemical Solution* 7
II. *Of chemical affinities* 17
III. *Of Caloric or the Matter of Heat* 26
IV. *Of the Matter of Light* 36
V. *Of the Atmoſphere* 38
VI. *Of Water* 47

THE MINERAL KINGDOM.

VII. *Of Salts in general* 53
VIII. *Of nitrate of Pot-aſh* 59
IX. *Of nitrate of Soda* 74
X. *Of nitrate of Ammoniac* 75
XI. *Of muriate of Soda* 77
XII. *Of muriate of Pot-aſh* 85
XIII. *Of muriate of Ammoniac* 86
XIV. *Of Sulphate of Pot-aſh* 89

Page.
XV. *Of ſulphate of Soda* 91
XVI. *Of ſulphate of Ammoniac* 92
XVII. *Of Borax* 93
XVIII. *Of borate of Pot-aſh* 96
XIX. *Of borate of Ammoniac* ibid.
XX. *Of the fluoric Acid* 97
XXI. *Of alkaline Fluates* 98
XXII. *Of the carbonic acid* 99
XXIII. *Of carbonate of Pot-aſh* 101
XXIV. *Of carbonate of Soda* 103
XXV. *Of carbonate of Ammoniac* 105
XXVI. *Of Earths in general* 107
XXVII. *Of calcareous Earth* 108
XXVIII. *Of ſulphate of Lime* 111
XXIX. *Of nitrate of Lime* 112
XXX. *Of muriate of Lime* 113
XXXI. *Of fluate of Lime* 114
XXXII. *Of borate of Lime* 115
XXXIII. *Of carbonate of Lime* 116
XXXIV. *Of Baryt* 117
XXXV. *Of ſulphate of Baryt* 118
XXXVI. *Of nitrate of Baryt* 119
XXXVII. *Of muriate af Baryt* 120
XXXVIII. *Of carbonate of Baryt* 121
XXXIX. *Of Magneſia* 122

Page
XL. *Of ſulphate of Magneſia* 122
XLI. *Of nitrate of Magneſia* 124
XLII. *Of muriate of Magneſia* 125
XLIII. *Of carbonate of Magneſia* 126
XLIV. *Of Alumine* 127
XLV. *Of Alum* 128
XLVI. *Of the other aluminous neutral Salts* 130
XLVII. *Of Silex* 131
XLVIII. *Of Jargon.* 133
XLIX. *Of the earth of adamantine Spar* ibid.
L. *Of inflammable Bodies* 134
LI. *Of the Diamond* ibid.
LII. *Of Sulphur* 135
LIII. *Of acids of Sulphur in general* 136
LIV. *Of the ſulphuric Acid* 138
LV. *Of the ſulphureous Acid* 139
LVI. *Of Sulphurets* 141
LVII. *Of the ſulphurets of Pot-aſh and Soda* ibid.
LVIII. *Of ſulphuret of Ammoniac* 144
LIX. *Of ſulphuret of Lime* 146
LX. *Of ſulphuret of Baryt* 147
LXI. *Of ſulphuret of Magneſia* 148
LXII. *Of Sal Polychreſt* ibid.
LXIII. *Of Fulminating powder* 149
LXIV. *Of Gun-powder* 150

Page

LXV. *Of Naphtha* 153

LXVI. *Of Petroleum and Malta* ibid.

LXVII. *Of Aſphaltum and Jet* 154

LXVIII. *Of Amber* 155

LXIX. *Of Ambergris* 158

LXX. *Of Copal* 159

LXXI. *Of Metals* 160

LXXII. *Of Gold* 165

LXXIII. *Of Platina* 169

LXXIV. *Of Silver* 171

LXXV. *Of Mercury* 176

LXXVI. *Of Copper* 187

LXXVII. *Of Iron* 191

LXXVIII. *Of Tin* 200

LXXIX. *Of Lead* 203

LXXX. *Of Antimony* 206

LXXXI. *Of Zinc* 217

LXXXII. *Of Biſmuth* 220

LXXXIII. *Of Nickel* 222

LXXXIV. *Of Cobalt* 223

LXXXV. *Of Manganeſe* 224

LXXXVI. *Of Arſenic* 227

LXXXVII. *Of Tungſten* 230

LXXXVIII. *Of Molybdena* 232

LXXXIX. *Of Uranite* 234

THE VEGETABLE KINGDOM.

Page
XC. *Examination of vegetable Bodies in a degree of heat equal to that of boiling Water* 235
XCI. *Of Infuſion* 238
XCII. *Of Decoction* 239
XCIII. *Of Extracts* 242
XCIV. *Of Fecula* 244
XCV. *Of diſtilled Waters* 247
XCVI. *Of etherial or volatile Oils* 251
XCVII. *Of Fat or fixed Oils* 254
XCVIII. *Of Wax, Reſins, Balſams, and Gums* 257
XCIX. *Of Camphor* 259
C. *Of Sugar* 260
CI. *Of the Salt of Sorrel* 262
CII. *Of the Benzoic Acid* 264
CIII. *Of the Citric Acid* 265
CIV. *Of the Malic Acid* ibid.
CV. *Of the Gallic Acid* 267
CVI. *Of other native vegetable Salts* 268
CVII. *Concerning the effects of a higher temperature upon Plants and their component Parts* 269
CVIII. *Of the particular effect of a higher temperature upon ſome of the parts of vegetables* 275

Page
CIX. *General conſideration of the remoter principles of plants.* 277
CX. *Of Fermentation in general* 278
CXI. *Of the ſpirituous Fermentation* ibid
CXII. *Of Tartar* 288
CXIII. *Of the acid Fermentation* 290
CXIV. *Of the putrefaction of Vegetables* 299
CXV. *Theory of Fermentation* 301
CXVI. *Of ſome particular pharmaceutical Preparations* 302

THE ANIMAL KINGDOM.

CXVII. *Of Milk* 309
CXVIII. *Of Blood* 318
CXIX. *Of the Pruſſic Acid* 325
CXX. *Of Bile* 328
CXXI. *Of the Gaſtric Juice* 330
CXXII. *Of Tears* 332
CXXIII. *Of Mucus* 334
CXXIV. *Of Saliva* ibid.
CXXV. *Of Pus* 336
CXXVI. *Of Semen* 338
CXXVII. *Of Fat* 339
CXXVIII. *Of Eggs* 342
CXXIX. *Of the white and ſoft parts of Animals* 344

Page
CXXX. *Of Muſcles* 345
CXXXI. *Of Bones* 346
CXXXII. *Of Phoſphorus* 350
CXXXIII. *Of Hair, Feathers, and Silk* 354
CXXXIV. *Of Synovia* 355
CXXXV. *Of Urine* - 358
CXXXVI. *Of the Calculus of the Bladder* 360
CXXXVII. *Of the Human Fæces* 362
CXXXVIII. *Of Sweat* ibid.
CXXXIX. *Of the Humour ſecreted in Dropſy* 363
CXL. *Of the Humour ſecreted by Bliſters* 364
CXLI. *Of the Formic Acid* 365
CXLII. *Of the Bombic Acid* 366
CXLIII. *Of Cantharides* 367
CXLIV. *Of Caſtoreum and Muſk* ibid.
CXLV. *General conſideration of the proximate and remote principles of animal Bodies* 368
CXLVI. *Of the putrefaction of animal Subſtances* 370
Outline of the Phlogiſtic Syſtem 373
Deſcription of Woulfe's Apparatus for Compound Diſtillation. 382

ERRATA.

Page	50	Line	3	*for* 07539	*read* 03539
Sect.	52	—	3	— combuſtion	— warmth.
Sect.	150	—	3	— earthly	— earthy
—	226	—	1	— oxy-muriatic acid	— nitro-muriatic acid.
Page	177	—	8	— precipitated	— precipitate
Sect.	625	—	10	— vegetables	— vegetable
—	756	—	4	— ley	— lie
—	772	—	8	— trous gaz	— nitrous gaz
—	1014	—	3	— bread	— tread

INTRODUCTION.

§. I. CHEMISTRY is that branch of natural philoſophy which unfolds the nature of all material bodies, determines the number and properties of their component parts, and teaches us how thoſe parts are united, and by what means they may be ſeparated and recombined.

§. II. Chemiſtry, therefore, is a practical ſcience, founded entirely upon experience, and accurate obſervation of the changes which bodies undergo during their mutual actions upon each other. When we compare thoſe changes, together with all their concomitant circumſtances, and reaſon accurately upon them, we find the laws agreeably to which they are produced, and are able to anticipate the reſults in ſimilar caſes. The aggregate of theſe laws, and their relation to one another, forms the Theory of Chemiſtry; and the means of proceeding, by which any chemical change is accompliſhed, are termed Experiments, Proceſſes, Operations.

§. III. The ſubjects upon which Chemiſtry is employed are all material ſubſtances capable of being included in veſſels; for this is neceſſarily required, in order that a body may be chemically examined. It is true, modern Chemiſts have begun to inveſtigate the properties of ſome bodies which, per ſe, and in an elementary ſtate, do not anſwer to this maxim; but, as Nature does not produce ſuch bodies in a ſimple, but always in a compound ſtate, therefore the limits which Boerhaave preſcribed in Chemiſtry, remain eſtabliſhed, viz. That a Chemiſt can inveſtigate thoſe bodies only which he is able to confine in veſſels.

§. IV. Although the proceſſes and experiments to which Chemiſts have recourſe to erect the vaſt edifice of their theory, be extremely numerous and diverſified, yet they may be reduced to two ſpecies, which comprehend the whole art of Chemiſtry. The firſt is analyſis, or decompoſition; the ſecond ſyntheſis, or compoſition. In analyſis, the parts, of which bodies are compoſed, are ſeparated from each other. Thus, if you reduce cinnabar, which is compoſed of ſulphur and mercury, into ſulphur and mercury, and exhibit thoſe two bodies in a ſeparate ſtate, you ſay, you have decompoſed, or analyzed cinnabar.

§. V. But if, on the contrary, ſeveral bodies be mixed together, and a new ſubſtance be produced, the proceſs is then termed chemical compoſition, or ſyntheſis. The cinnabar, already mentioned, may afford us another example; for, if, by fuſion and ſublimation, you combine mercury with ſulphur, and thus produce cinnabar, the operation is termed, chemical compoſition or compoſition, by ſyntheſis.

§ VI. When a body is thus chemically reduced, and its principles obtained pure, and preciſely in the ſame ſtate in which it contained them, we readily conclude, that that body muſt be compoſed of ſuch principles; and that the inference is juſt is proved by ſyntheſis, when, by a recombination of theſe principles, the former body is invariably obtained. This was ſeen in our firſt example, where, from the decompoſition of cinnabar, we obtained ſulphur and mercury, which bodies, being afterwards recombined, formed cinnabar.

§. VII. Such caſes, however, occur but rarely in chemical operations; for, during the decompoſition of a body, its conſtituent parts are apt to combine, either with the ſolvent, or with the principles diſengaged at the ſame time, and thus new forms are induced. We ſhould be greatly deceived, therefore, if, after ſuch proceſs, we were to conſider the parts obtained as the true principles of the body decompoſed; nor ſhould we, by recombining thoſe parts, ever be able to form again the original body. From wood, for inſtance, you obtain, by analyſis, a liquid acid, an empyreumatic oil, calcareous earth, pot-aſh, and a ſmall quantity of iron; which, when united, never conſtitute any thing ſimilar to wood, though ſuch principles are conſidered as the component parts of wood.

§ VIII. Hence, analyſis, on account of the two-fold iſſue of all chemical operations, is properly divided into two claſſes. The firſt is ſimple or true analyſis; the other ſpurious or complex analyſis. The former rarely occurs, and then only when a body is reduced to its principles in ſuch a manner that they are unchanged, and preciſely the ſame as contained in the body; and are capable, when combined, of forming a body not at all different from the former. The latter, however, happens more frequently, and generally furniſhes the principles of a body in a ſtate of combination.

§ IX. Although the products of complex analyſis do not enable us immediately to judge of the ultimate principles of bodies, yet this method affords almoſt the only means to Chemiſts by which that purpoſe may be accompliſhed; and the rapid progreſs which Chemiſtry has made, eſpecially within theſe laſt twenty years, has ſo greatly improved the knowledge of the more ſimple bodies, that we are frequently enabled, by means of the ſeveral products of numerous double decompoſitions, variouſly directed, to define the true principles of bodies, and even their relative proportions.

§ X. All material bodies are either ſimple, conſiſting of parts alone ſimilar to each other, and of the ſame nature, or combined, conſiſting of parts diſſimilar, and of a different nature. The former, which admit of no chemical analyſis, are termed by Chemiſts, firſt principles or elements. Theſe, however, ought not to be confounded with the elements of natural philoſophers; for, where the Chemiſt leaves off, there the natural philoſopher only begins: for inſtance, when a body cannot further be reſolved into diſſimilar parts, the Chemiſt then terms it ſimple, and conſiders it as an element; but, the natural philoſopher proceeds to divide this body, which the Chemiſt conſiders as ſimple, into parts ſimilar to each other, until he at length arrive at ſuch as reject all further diviſion; and theſe atoms he terms elements. Theſe elements, not being perceptible to the ſenſes, can only be conſidered as exiſting in the imagination of the philoſopher; but the contrary holds good with reſpect to the elements of the Chemiſt.

§ XI. The old Chemiſts, becauſe they deſpaired of ever acquiring a knowledge of the elements by means of analyſis, indulged themſelves in mere ſpeculations, and adopted hypothetical elements, of which they inſiſted all the bodies of nature were compoſed. Thus Ariſtotle, and the peripatetic philoſophers of his ſchool, believed, that all bodies conſiſted of different modifications of fire, air, earth, and water. Paracelſus, and the Alchymiſts of his time, adopted mercury, ſulphur, ſalt, and earth. Becher conſidered water, and three different ſpecies of earth, as the elements of all bodies, viz. vitrifiable earth, inflammable earth, which was likewiſe called phlogiſton, and mercurial, or metallic earth. Although I ſhall be ſilent as to the opinions of other philoſophers, yet I ſhall mention Meyer, who, in our own recollection, propoſed four elements, water, earth, the matter of light, and his acidum pingue. All theſe hypothetic ſyſtems have met the ſame fate; at firſt they were eagerly adopted, nay, applauded; afterwards attacked, then defended, and at laſt forgotten.

§ XII. How much more prudent are the moderns, who, having uſed every effort to expel all hypotheſis, and reaſoning ſolely upon direct facts, throw aſide that doctrine of the elements which is grafted upon ſuppoſitions and errors, and think it ſufficient to conſider all thoſe bodies, of which the compoſition has not been aſcertained by concluſive experiment, as in reality ſimple. Bodies of this kind are known by the qualified term baſes, or radicals; by which title they neither deny the poſſibility of yet being decompounded, nor confirm the contrary. At preſent, the number of theſe baſes is conſiderable; but, from the induſtry of the Chemiſts, we may reaſonably expect that it will be gradually diminiſhed, and that means will be diſcovered by which ſome of theſe baſes may be reduced to their elementary principles. Till that has been effected, there can be no heſitation in ranking them among ſimple, or elementary bodies. Oftentimes, indeed, an enlightened Chemiſt forms conjectures reſpecting the probability of decompounding theſe baſes, and augurs ſcientifically, as to the nature of their elements, or principles, but does not enter theſe hypothetic ideas into the annals of his ſcience, till they are confirmed by experiment.

I. OF CHEMICAL SOLUTION.

§ XIII. In all bodies of nature there exiſts a certain innate power which urges them to approach each other. This is called the power of attraction, for which philoſophers have, to this day, vainly endeavoured to account. Natural philoſophy only teaches us the laws agreeably to which this power acts with more or leſs energy, according to the ratio of the maſſes, and the diſtances of the bodies from each other; and only ſhews us how we may arrive at a knowledge of thoſe remarkable phenomena, produced by the attraction of greater maſſes of matter, commonly termed gravity, levity, weight, deſcent, aſcent, &c. of bodies.

§ XIV. Now the ſame power of attraction which manifeſts itſelf between the entire maſſes exiſts, likewiſe, between the minuteſt particles of each individual maſs; and the exiſtence of maſſes is ſimply owing to that power. This attraction by which the elementary particles of a body mutually act upon each other, and to which the body owes its greater or leſs coherence, is called the force of aggregation or coheſion. Although the laws, whereby this power acts upon ſuch particles, ſeem to vary according to the nature of bodies, and are not yet pointed out and defined as accurately as thoſe reſpecting the attraction of maſſes at great diſtances, yet it has been proved that they ariſe from the ſame cauſe, and that it is the ſame power which confines the heavenly bodies within their orbits, and which cauſes the ſmalleſt particle of marble to appear in the form of a maſs.

§ XV. Let us ſuppoſe a certain maſs of marble to be a ſimple body, and to conſiſt of an infinite number of minute particles, alike in form, ſize, and chemical properties, in a word, alike particles of marble, theſe, which we term elementary particles or molecules, adhere to ſuch a degree, on account of the reciprocal attraction which exiſts between them, that they cannot be ſeparated from each other but by a great mechanical force, and this conſtitutes what is termed coheſion.

§ XVI. But this power varies conſiderably according to the nature of bodies; in ſome it acts more, in others leſs forcibly. Thus we know that it is much more difficult to reduce a piece of iron into fragments than a piece of chalk, and the coheſion of the iron is therefore greater than that of the chalk. In theſe inſtances, it is not, however, in our power to point out the laws of coheſion, and the ſcale of its increaſe or diminution, with the ſame accuracy as between bodies at great diſtances, where coheſion is known to be in a direct ratio of the maſſes, and in an inverſe duplicate ratio of the diſtances. Theſe circumſtances are perfectly unknown to us with regard to the elementary particles or molecules, and we have but a few data which can lead us to a knowledge of it. Let it ſuffice, therefore, to ſay, that the power of coheſion differs in every material body.

§ XVII. But in the ſame manner as the homogeneous particles of a ſimple body tend, by the reciprocal action of cohesion, towards each other, ſo the particles of different bodies are alſo mutually attracted. Therefore, whenever two heterogeneous bodies come into contact with each other, ſo that the power of reciprocal attraction between the molecules of each may be exerted, and when this attraction is even ſtronger than the power of coheſion of each ſingle body collectively, then the homogeneous particles will ſeparate, and combine with all thoſe heterogeneous particles with which they come into contact, forming a new compound body. A phenomenon of this nature is termed by chemiſts, ſolution; and the power of attraction, which exiſts between the conſtituent particles of two different bodies, is termed chemical affinity, or attraction of compoſition.

§ XVIII. Affinity, therefore, differs from coheſion only in this; that the action of the latter is exerted upon the homogeneous particles of a ſimple body only, whereas the former exerciſes its power upon the heterogeneous particles of two different bodies.

§ XIX. For inſtance, take a piece of pure lime and immerſe it in nitric acid, ſoon after theſe two bodies begin to act upon each other, a certain quantity of heat is developed; the lime gradually diſappears, and the liquid recovers its former tranſparency. What is the cauſe of this phenomenon? The lime is a ſolid body, whoſe elementary particles are attached to each other by the power of coheſion, and the particles of the nitric acid, which is a liquid body, are alſo attached to each other by coheſion; but there is moreover an affinity between the nitric acid and the lime, that is to ſay, the particles of the nitric acid have an attractive power upon the particles of the lime. Now, if the power of coheſion of the nitric acid and of the lime were greater than their affinity for each other, each of theſe bodies would remain in the ſame ſtate, and no combination would take place. But, as in the caſe before us, the chemical affinity far exceeds in power the coheſion, the molecules of theſe two bodies are ſeparated, and mutually recombine, forming a new and uniform body; and the particles of the lime, which were before connected by coheſion, are now united to the particles of the nitric acid by affinity.

§ XX. Chemical ſolution is very different from mechanical mixture. In the latter, the aggregate particles can again be ſeparated by mechanical means, and the proportion of the different particles determined. But, in ſolution, no mechanical power whatſoever can ſeparate them; beſides, the particles are ſo very ſmall as not to be perceived even by the beſt microſcope; and yet, on the minuteſt diviſion, every particle will be of the ſame nature with the body itſelf.

§ XXI. Coheſion is always much greater in ſolids than in fluids; and hitherto we have not had one inſtance of an affinity being ſo great between two ſolid bodies as to overcome their coheſion. In order, therefore, that two ſolid bodies may be chemically combined, it is neceſſary that in one of them, at leaſt, coheſion ſhould be greatly diminiſhed, which is effected by rendering it fluid; for thus the molecules are farther removed from each other; and, conſequently, their reciprocal attraction being weakened, the affinity becomes predominant, and a combination takes place. Hence you obſerve no change takes place when ſulphur is brought into contact with ſilver, although there exiſts a great affinity between them; but if the ſulphur be fuſed, it will immediately arreſt the ſilver. Therefore, in general, if two bodies are to be chemically combined, it is always neceſſary that one of them, at leaſt, ſhould be fluid; and this circumſtance has given riſe to the old maxim, *corpora non agunt niſi fluida.*

§ XXII. We are only acquainted with two means by which a ſolid body may be rendered fluid, without changing any of its chemical properties, viz. fire and water. Hence ſolutions are divided into two kinds; for bodies combine when rendered fluid, either by water, which combination is called ſolution in the moiſt way, or by fire, which is termed ſolution in the dry way. For inſtance, in our experiment, (§ XIX.) the nitric acid becomes liquid by ſolution in water, and conſequently the ſolution is in the moiſt way; but the combination of ſulphur and mercury, (§ V.) is a ſolution in the dry way.

§ XXIII. Moreover, as ſolution can only take place when the ſurfaces of the particles of the bodies come into direct contact, that operation will be by ſo much the more readily performed, as the ſurfaces of the bodies in contact, are greater and more numerous. Therefore, in the ſolution of a ſolid body in the moiſt way, we uſually firſt divide it into ſmall pieces by mechanical means; and inthe ſolution of ſuch bodies in the dry way, they are not only mechanically divided, but mixed as much as poſſible, previous to their treatment by fire; becauſe, in both caſes, the ſurfaces of the bodies are conſiderably increaſed, and, conſequently, their ſolution is proportionably facilitated.

§ XXIV. Although many bodies that have an affinity for each other may be combined in any proportion we pleaſe, yet there are others, and by far the greater number, in which ſolution extends only to a certain point; that is, any body A can only diſſolve a certain quantity of another body B, beyond which it does not act, but ſeems to have loſt its former affinity. This degree of ſolution is termed the point of ſaturation, and it is then ſaid that the body A is ſaturated with the body B. Thus we find in our experiments (§ XIX.) that the nitric acid has diſſolved a certain quantity of lime; but ſhould another portion of this body be added, it would remain undiſſolved, the acid having no effect upon it, being already ſaturated with lime.

§ XXV. The point of ſaturation, in homogeneous bodies, under ſimilar circumſtances, is always the ſame, but very different in heterogeneous bodies.

Thus, for inſtance, if in the former experiment we had taken particular notice of the weight both of the nitric acid and of the lime, we ſhould have found that 100 grains of that acid diſſolve exactly 96 grains of the lime; and that proportion would always be obſerved, whenever lime is diſſolved in the nitric acid. In the combination of nitric acid with a different body, however, a certain point of ſaturation is indeed obſerved, but according to different laws; for example, it diſſolves a much greater quantity of pure pot-aſh than of lime; thus 100 grains of nitric acid diſſolve 215 grains of pot-aſh, which, therefore, is more than double the quantity of the lime.

§ XXVI. The temperatures, or different degrees of heat, in which ſolutions are made, have alſo a very great influence upon the point of ſaturation; and bodies frequently diſſolve much more in hot than in cold temperatures; thus hot water diſſolves a greater quantity of ſugar than cold. Therefore, whenever we ſpeak of the point of ſaturation of two bodies, it is neceſſary to mention the temperature at which the ſolution is made.

§ XXVII. Although, during the combination of two bodies, their power be reciprocal, and their attraction towards each other equal, yet chemiſts uſually term one of the bodies the ſolvent, and the other the body diſſolved. The former is alſo called the menſtruum, becauſe the alchymiſts uſed to make their ſolutions in the ſpace of a month. But to determine which is the ſolvent, or which the body diſſolved, is a matter altogether arbitrary; yet the following definition appears moſt conformable to our received notions: The ſolvent is that of two bodies, whoſe external form approaches neareſt to the form of the body which is produced by their combination. Thus, in the ſolution of lime in the nitric acid, this acid is the ſolvent, becauſe the ſolution remains liquid; but, in the combination of ſulphur with mercury, the ſulphur is the ſolvent, for Æthiops mineral, ſo formed, is a ſolid body.

§ XXVIII. The greater eſteem this trifling diſtinction was held in among the Chemiſts of former ages, the more is it diſregarded by the moderns, from which we may eaſily judge of its merits. For ought we, whoſe ſole object it is to follow nature, to make diſtinctions where ſhe points out none? If, during the combination of two bodies, therefore, we do not obſerve that one of them poſſeſſes a greater power of attraction than the other, it is ſuperfluous, on that account, to aſſign a different order to theſe bodies, eſpecially as the opinion which formerly gave riſe to this diſtinction, is at preſent entirely laid aſide. The Alchymiſts believed that their menſtruum conſiſted of a great number of ſmall particles, formed like wedges, points, ſpears, &c. which, during ſolution, penetrated into the pores of the body, and thus cauſed it to be divided; a doctrine, which, in the preſent ſtate of our knowledge, merits no farther refutation.

§ XXIX. On comparing a new body, produced by ſolution, with the bodies from which it has been compoſed, we ſhall find, that it frequently poſſeſſes ſome properties in common with thoſe bodies. On the other hand, we find no leſs frequently that it entirely differs. Stahl, therefore, and his contemporaries, were much miſtaken, when they ſuppoſed that the properties of a compound body, held a medium between the properties of thoſe from which it had been formed; for although we ſee that the combination of two metals produces one, which poſſeſſes certain properties of the ſame nature, yet, on the contrary, we know, that from aqua fortis and lapis cauſticus we compoſe a ſalt perfectly mild and harmleſs; and that from the acid of common ſalt and mercury, bodies in themſelves innocent, we form mercurial ſublimate, a dreadful poiſon; that from liquids a ſolid, and from ſolids a liquid; from colourleſs, a coloured body; from coloured bodies, colourleſs ones; from inodorous, odorous ones, and *vice verſâ* may be formed. In a word, the properties of a compound body, by analogy, teach us nothing certain reſpecting the properties of its conſtituent parts: and two bodies, which combine, on account of their chemical affinity, form a new body, the properties of which have no ſimilarity with the properties of the bodies combined, but are oftentimes entirely different.

§ XXX. When two bodies only enter into chemical union, the affinity, which was the cauſe of it, is termed ſimple, or ſingle elective attraction. But if three or more bodies, on account of their mutual affinity, unite, and form one homogeneous body, then the affinity is termed compound, or double elective attraction. Thus the ſolution of ſugar in water is produced by ſimple affinity, becauſe theſe are but two bodies; but if you add ſpirits of wine, theſe three bodies will form a homogeneous liquid by compound affinity. Simple affinity, in the ſtricteſt ſenſe, occurs but rarely; for bodies are generally compoſed of more than two parts.

§ XXXI. During ſolution, the elementary particles of bodies only mutually act upon each other, and every individual particle acts with the ſame force. Hence it is evident, that, after combination has taken place, the conſtituent parts of the new compound are ſo equally diſtributed throughout the whole body, that, if the ſmalleſt particle were ſeparated by mechanical means, we ſhould find that the proportion of its component parts is preciſely the ſame as that of the whole maſs. Thus, when we know that in the ſaturated ſolution, (§ XIX) 100 grains of nitric acid diſſolve 96 grains of lime, we conclude, that in any part, even in the minuteſt drop of this compound liquid, the proportion of the nitric acid to the lime is as 100 to 96.

§ XXXII. The knowledge of this law of ſolutions is, indeed, of the higheſt importance, becauſe thoſe experiments are chiefly founded upon it which we inſtitute for the purpoſe of inveſtigating the nature of bodies. For, if, on examining the ſmalleſt quantity of any maſs, we determine the proportion of its component parts, we have every right to conclude, from a knowledge of that law, that the proportion of thoſe parts is the ſame throughout the whole maſs. The confidence which we put in the value of coin reſts entirely upon it, as we are aſſured, that, when two metals are chemically combined, in certain proportions, the ſame proportion is obſerved in the minuteſt parts which can be ſeparated from the maſs, and, conſequently, that in the ſmalleſt coin there is the ſame proportion of gold, or ſilver, as in the maſs of which it forms a part.

II. OF CHEMICAL AFFINITIES.

§ XXXIII. Although the obſervations hitherto made are highly valuable, as they lead us, in a great meaſure, to a true knowledge of the chemical compoſition of bodies, yet there remains another moſt important conſideration, which is the baſis of our ſcience, and without which it could not exiſt; that is, though there may be a chemical affinity between almost all bodies, yet the tendency which they have to enter into combinations is in ſome bodies ſtronger, in others weaker; and, conſequently, there are various degrees of affinity. For inſtance, A has an affinity for B, and has, likewiſe, an affinity for C; but the power by which A attracts B may be either greater or leſs than that with which it attracts C, and for this reaſon A is ſaid to have a greater or leſs affinity for B than for C.

§ XXXIV. From the various degrees of affinity of bodies it naturally follows, that, if to two bodies, already chemically united, a third be added, whoſe affinity for one of them is greater than that of the two bodies for each other, then their union is diſſolved, and the body recently added, by expelling one of the components, produces a new body with the other. If pure pot-aſh, for inſtance, be added to a combination of the nitric acid and lime, the union which exiſted between theſe two bodies will ceaſe, becauſe the pot-aſh combines with the nitric acid, and the lime, being diſengaged, is precipitated. The reaſon is, that the nitric acid has a greater affinity for the pot-aſh than for the lime, therefore it deſerts the lime to combine with the pot-aſh.

§ XXXV. In this laſt experiment, the body which has been expelled, by the intervention of a third, is precipitated, that is, it falls to the bottom of the veſſel containing the ſolution. This, however, is not always the caſe, for it frequently happens that the body expelled is diſſipated in the form of an aerial fluid; thus, on combining carbonate of pot-aſh, which conſiſts of pure pot-aſh and carbonic acid, with the nitric acid, the carbonic acid paſſes into the air in the ſtate of gaz, becauſe the nitric acid has a greater affinity for the pure pot-aſh than for the carbonic acid. The rapid formation of bubbles, on this occaſion, cauſed by the ſudden diſengagement of the carbonic acid, is termed efferveſcence; and thus the carbonate of pot-aſh is ſaid to efferveſce with acids.

§ XXXVI. This mode of proceeding, to diſſolve the union of two bodies by the addition of a third, which has a greater affinity with one of them, is that which is generally employed by Chemiſts in their analyſes: from which we may infer, how extremely important it is, to thoſe who wiſh to obtain a knowledge of the ſcience, to be acquainted with the different degrees of affinity of all bodies. In a word, one may ſafely aſſert, that the whole of the ſcience conſiſts in a knowledge of theſe facts.

§ XXXVII. Stahl firſt more attentively conſidered this property of bodies, and furniſhed us with the happy idea of degrees of affinity, which others have ſucceſſively extended. Geoffroy, in 1718, made the firſt attempt to collect all the facts, known on that head, and to arrange them, for the ſake of greater conveniency, in a table, which he denominated a table of affinities. In this table, all known bodies, repreſented by peculiar ſigns, are ranked in that order in which, on account of their greater or leſs affinity, they tend to combine; ſo that, whenever we wiſh to decompoſe a compound ſubſtance, we may readily know, by means of this table, what bodies have a greater affinity with one of its component parts than the elementary parts of that ſubſtance have with each other, and conſequently which may decompound it.

§ XXXVIII. Chemiſts have afterwards enlarged and corrected this table by innumerable experiments, and, among others, two celebrated men, Gellert of

Freyberg, and Bergmann, deſerve particular notice. The former not only enlarged this table by a great many operoſe experiments, but likewiſe added a new column for thoſe bodies which were proved to have no affinity with each other. The latter endeavoured to advance the chemical table, already greatly improved, to a ſtate of perfection, by the various diſcoveries of the moderns. He alſo diſtinguiſhed the affinities of thoſe bodies which are ſoluble in the moiſt way, from thoſe which are ſoluble in the dry way, and, for this reaſon, his table comprehends two diviſions. It contains fifty compartments, in which the bodies are ranged after Geoffroy's method; that is, bodies which have the greateſt affinity with the body at the head occupy the next compartment. This mode is reverſed in Gellert's table.

§ XXXIX. If a body, conſiſting of two component parts, be decompounded on the approach of a third, which has a greater affinity with one of thoſe component parts than with the other, then the decompoſition is termed, *decompoſition by ſimple affinity*. This was the caſe in the examples (§ XXXIV. and § XXXV.) where the lime was ſeparated from the nitric acid by pot-aſh, and the carbonic acid from the pot-aſh by the nitric acid; for, in both theſe caſes, the decompoſition was ſolely effected by the affinity of the approaching body with one of the component parts.

§ XL. But, if two bodies, each conſiſting of two elementary parts, come into contact, and be decompoſed, ſo that their elements become reciprocally united, and produce two new compound bodies, the decompoſition is then termed *decompoſition by double affinity*. For inſtance; if we add common ſalt, which conſiſts of the muriatic acid and ſoda, to nitrate of ſilver, which is compoſed of nitric acid and ſilver, theſe two bodies will be decompounded, for the nitric acid unites with the ſoda, and the ſilver with the muriatic acid, and thus we obtain two new bodies. The common ſalt and nitrate of ſilver, therefore, mutually decompoſe each other by double affinity.

§ XLI. The cauſe of this phenomenon is the ſame as that of decompoſition by ſimple affinity, except that, in this caſe, the affinities of all the four component parts are to be conſidered. Thoſe two bodies are decompounded, becauſe the ſum of the affinities of the parts of one body, with thoſe of the other, is greater than the ſum of the affinities which the parts of each reſpective body have with each other. The former are denominated divellent, and the latter quieſcent affinities. If, therefore, the ſum of the divellent affinities of the bodies be greater than the ſum of the quieſcent affinities, a decompoſition is effected; on the contrary, if the quieſcent affinities be greater than the divellent, the bodies remain in the ſame ſtate.

§ XLII. As all poſſible caſes may be referred to theſe two kinds of decompoſition by affinity, it is unneceſſary to treat of thoſe numerous claſſifications of affinities which ſome chemiſts have propoſed, and which can anſwer no other purpoſe than to charge the memory with an uſeleſs nomenclature. Of this kind are the terms *appropriate affinity*, *preparative affinity*, &c. both of which may be eaſily explained, ſince every compound body poſſeſſes a diſtinct ſcale of affinity, and which is oftentimes very different from that of the affinities of its component parts.

§ XLIII. Although tables of affinities furniſh us with a ſcale of the degrees of affinity between different bodies, yet we were not able to expreſs the proportion of thoſe degrees by numbers, till the celebrated Kirwan took the ſubject in hand, and treated it with that ingenuity and method ſo peculiar to himſelf. Whilſt he was engaged in various experiments, to determine the different points of ſaturation in different bodies, he made a moſt valuable diſcovery, viz. that the points of ſaturation are preciſely as the degrees of affinity. Thus, if a certain quantity of A can diſſolve two parts of B, and four parts of C, the affinity which A has with B and with C will be exactly as the quantities which A can diſſolve of B and of C, namely, as 2 to 4. For inſtance, 100 grains of nitric acid require for complete ſaturation 96 grains of lime, but 100 grains of the ſame acid diſſolve 215 grains of pot-aſh; therefore, according to Kirwan, the affinity of the nitric acid with the lime is to the affinity of the nitric acid with the pot-aſh as 96 : 215.

§ XLIV. Since the quantities which any body can diſſolve of two other different bodies, with which it has an affinity, are in an inverſe ratio of the quantities which thoſe two bodies can take up of the firſt, this law of Kirwan may be explained in two ways:

1. The quantities of two bodies, which can be diſſolved by a given quantity of a third, are to each other as the affinities of thoſe two bodies to the third.

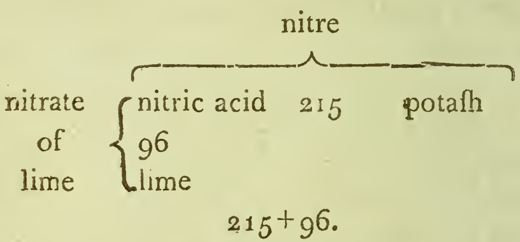
2. The quantities of a body, which can be diſſolved in equal quantities of two other different bodies, are to each other in an inverſe ratio of the affinities of the firſt body with the two laſt.

Moreover, the truth of this poſition is not only proved by experiments, but may be alſo deduced from the former poſition, and demonſtrated mathematically.

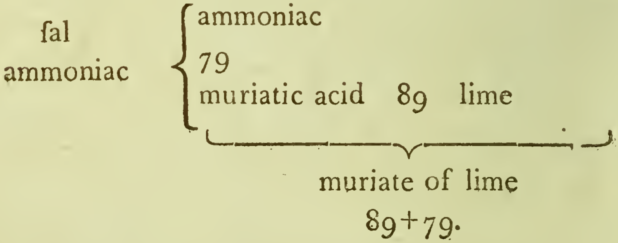
§ XLV. As the affinity of bodies is always determined by acids, in the moiſt way, Kirwan, therefore, to expreſs himſelf more generally, indicates the degree of affinity of a body with an acid, by the quantity of that body which is diſſolved in 100 parts of any given acid. Thus, according to him, the affinity of lime with nitric acid is 96, the affinity of pot-aſh with that acid 215, the affinity of lime with the ſulphuric acid 110, and ſo on. In this manner he determined, by numerous and elaborate experiments, in reſpect to acids, by the moiſt way, the points of ſaturation of different bodies, and expreſſed their affinities by numbers.

§ XLVI. From this proportionate determination of the degrees of affinity, we frequently know, without having recourſe to progreſſive experiments, whether or not certain bodies be capable of decompoſing this or that compound ſubſtance. For example, take a body compoſed of the nitric acid and lime; we know that the affinity between thoſe two bodies is as 96; but we alſo know, that the affinity between nitric acid and pot aſh is as 215. Therefore, we may infer, that pot-aſh will decompoſe this compound ſubſtance.

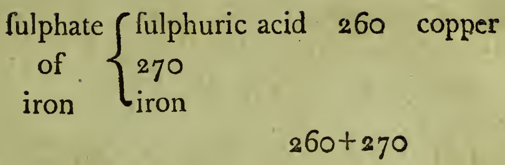
§ XLVII. For the ſake of greater perſpicuity, ſuch decompoſition may be expreſſed, according to Bergmann, in the following manner:



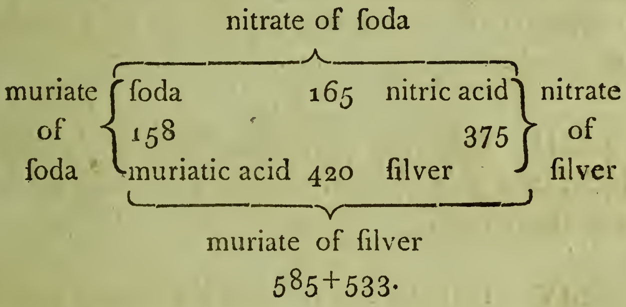
§ XLVIII. And thus, alſo, the decompoſition of ſal ammoniac, by means of lime:



§ XLIX. But if the divellent affinity be leſs than the quieſcent, no decompoſition is effected, as, for inſtance, when copper is added to ſulphate of iron:



§ L. The utility of marking affinities by numbers is ſtill farther elucidated in decompoſition by double affinity; for we can now clearly define and compare the ſums of the divellent and quieſcent affinities, as in the reciprocal decompoſition of nitrate of ſilver, and muriate of ſoda:



§ LI. Although the utility of this method be obvious, yet it is much leſs prevalent than might be wiſhed, becauſe the degrees of affinity of many ſubſtances, analyzed in the moiſt way, are not yet determined with ſufficient accuracy, and little has been done upon this principle in the dry way.

III. OF CALORIC, OR THE MATTER OF HEAT.

§ LII. Philoſophers formerly differed in opinion reſpecting the cauſes of thoſe phenomena, known by the terms heat, combuſtion, cold; and there were many who conſidered them merely as the effect of the mechanical changes of bodies. At preſent, however, it is almoſt unanimouſly agreed, that theſe effects are produced by a peculiar matter which has received the name of caloric, and which, in general, enables us to explain thoſe appearances fully, and in a ſatisfactory manner.

§ LIII. Caloric is an impenetrable fluid, highly elaſtic, and ſo very ſubtle that its gravity has not yet been aſcertained.

§ LIV. It is diffuſed through all natural bodies, with which it is more or leſs combined, according as their affinities for it are greater or leſs. We are not acquainted with any body that does not enter into combination with it; nor any, from which the utmoſt endeavours could entirely ſeparate it; and caloric, therefore, is not to be had in a pure ſtate in nature; nor can chemiſtry, in the ſtricteſt ſenſe, exhibit any ſubſtance perfectly ſimple. Hence, Chemiſts, when mentioning the conſtituent parts of bodies, pay no regard to the preſence of caloric, but conſider it as underſtood of courſe.

§ LV. All bodies, therefore, are chemically combined with a certain portion of caloric; or, to expreſs it in other words, the molecules of every ſubſtance are intermixed in an uniform proportion with the particles of caloric, and kept apart by them. Hence the elementary particles of bodies do not, in fact, touch each other; and this is manifeſt from the property which all bodies poſſeſs, of being contracted into a leſſer volume when deprived of heat.

§ LVI. Caloric, being a ſubſtance perfectly elaſtic, whoſe component particles would expand in infinitum if not impeded, all bodies combined with them ought likewiſe to expand in infinitum, if there exiſted no power which acted in direct oppoſition to its elaſticity. This power is the mutual attraction of the particles, or coheſion. All material bodies, therefore, are continually acted upon by two powers, which tend more or leſs to equipoiſe each other; one cauſes the particles of bodies to recede from each other, and by the other they tend to approximate.

§ LVII. The proportion of each of theſe powers determines the exterior form of bodies. If coheſion predominate, then the bodies are ſolid; but, if this power be overcome, then the particles are further removed, and their volume is proportionally increaſed. Finally, if caloric predominate to ſuch a degree, that the particles of bodies are placed out of the ſphere of their reciprocal attraction, they loſe their aggregation, and appear no longer in the form of ſolids, but become liquid or gazeous.

§ LVIII. But, if there exiſted no other power but the two already mentioned, bodies would not remain liquid; for, on increaſing the heat, they would immediately paſs from the ſolid to the æriform or gazeous ſtate. But there is a third power, which, by acting at the ſame time, preſerves them in an intermediate or liquid ſtate. This power is the preſſure of the atmoſphere, without which there would be no liquid in nature, for all bodies would be either ſolid or æriform.

§ LIX. Hence all bodies, from their combination with caloric, may exiſt in three different ſtates, which reſult from:

1. The power of attraction by which bodies cohere.
2. The quantity of caloric with which the ſubſtance is combined.
3. The greater or leſs preſſure of the atmoſphere.

§ LX. The means by which a ſolid body may be changed into a liquid are, therefore:

1. A combination with a new and ſufficient quantity of caloric, and
2. An union with another body already liquid.

The operation by which a body is rendered liquid, according to the firſt method, is termed fuſion, the theory of which is clear from what has been advanced. In the ſecond caſe, a body becomes liquid, if the quantity of caloric, in the liquid body added, be ſufficient to remove the elementary particles of the new compound, to ſuch a diſtance as will diminiſh their coheſion as far as neceſſary.

§ LXI. A liquid body is rendered ſolid,

1. By the loſs of a portion of its caloric.

2. By combining it with another ſolid body.

In the former caſe, a body parts with that portion of caloric whereby it overcame the repelling force of the molecules, which now approach nearer to each other; ſo that they are again acted upon by coheſion. This change of bodies is termed congelation. In the latter caſe, the compound body becomes ſolid, if the caloric, preſent in the liquid, be not ſufficient to prevent the attraction of the conſtituent particles of the new body, ſo as to cauſe it to be acted upon by coheſion.

§ LXII. A liquid is changed into the ſtate of gaz,

1. By being combined with a quantity of caloric ſufficient to equipoiſe the preſſure of the atmoſphere.

2. If the preſſure of the atmoſphere be either ſufficiently diminiſhed, or totally removed.

§ LXIII. A gaz becomes liquid,

1. By the loſs of that ſuperabundant portion of caloric which reſiſted the preſſure of the atmoſphere.

2. By ſufficiently increaſing that preſſure.

§ LXIV. Hence, in every elaſtic fluid, two principal objects are to be conſidered: firſt, the caloric which gives it its exterior form, viz. that of gaz.—Secondly, the body diſſolved by the caloric, and by which the peculiar chemical properties of the gaz are determined. This latter is generally termed the baſis, which we muſt be cautious not to confound with the gaz itſelf.

§ LXV. Caloric continually tends to form an equilibrium. Hence it is, that, if two bodies of the ſame nature, for inſtance, two pieces of the ſame metal, be unequally heated, or combined with different portions of caloric, and brought into contact with each other, the caloric equally diffuſes itſelf throughout the two bodies; and the quantities of caloric, in each body, will bear the ſame proportion to each other as the maſſes themſelves.

LXVI. But, ſuppoſing the two bodies to be of a different kind, in that caſe, though the caloric would alſo form an equilibrium, and each body would indicate the ſame temperature to the thermometer, yet the proportions of caloric in each body, will not be as the maſſes, but will vary according as the bodies differ.

§ LXVII. This property of bodies, to require different quantities of caloric to indicate the ſame temperature to the thermometer, was termed by Dr. Black, the capacity of a body for heat; but the quantity of caloric itſelf he called ſpecific heat. The cauſe of this phenomenon ariſes from the different degrees of affinity which different bodies poſſeſs for caloric, and from which the capacities, and various points of ſaturation, of different bodies may be eſtimated.

§ LXVIII. When any body is in equilibrio with the bodies which ſurround it, with reſpect to its caloric, that quantity which it contains is not perceptible by any external ſign or organ of ſenſe, and is termed combined caloric, or, according to Black, latent heat.

§ LXIX. But, if the latent heat, from any cauſe, be forced, in ſome degree, to quit a body, and to combine with thoſe that ſurround it, then ſuch caloric is ſaid to be free or ſenſible until the equilibrium is reſtored.

§ LXX. It is this caloric in a free ſtate which acts upon our organs, and excites that ſenſation which we term warmth; and it is this alone which we can aſcertain by the thermometer. The temperature of a body is, therefore, the termination of the rarefaction of the mercury, at the inſtant when its caloric has eſtabliſhed an equilibrium with that of the body.

§ LXXI. The equilibrium of caloric is deſtroyed by the following cauſes:

1. A change of the capacities in bodies by chemical analyſis or ſyntheſis.
2. External mechanical preſſure.

As to the former, the reaſon of the ſeparation or addition of caloric is to be ſought for from the general laws of chemical compoſition already mentioned, viz. that a compound body poſſeſſes properties different from its conſtituent parts. Hence the capacity of the compound body is not always a mean between the ſum of the capacities of its conſtituent parts, but is oftentimes greater or leſs; and, on account of this greater or leſs capacity of a compound body, caloric, at the moment the conſtituent parts unite, is either expelled or attracted from ſurrounding bodies. In the former caſe, the temperature of the ſurrounding bodies is increaſed, in the latter it is diminiſhed.

§ LXXII. When a body, whoſe temperature has been determined, comes into contact with ſeveral other bodies of lower temperatures, then the caloric endeavours to form an equilibrium; and that of the firſt body, becauſe it is this eſpecially, which cauſes a change in the equilibrium, diffuſes itſelf throughout the ſecond, and from thence throughout the third, and ſo in ſucceſſion till all their temperatures be equal. The intermediate bodies, through which caloric permeates, are called conductors of heat, and, as they convey it more or leſs quickly, they are ſaid to be good or bad conductors.

§ LXXIII. All bodies poſſeſs the property of communicating caloric, but according to different degrees, being hence termed good or bad conductors. Hitherto we know of but one exception, which is in congealed water or ice. This body imbibes all the caloric which it receives from other bodies; nor does it communicate the leaſt quantity to ſuch as lie contiguous to it, until the quantity of caloric it has abſorbed has rendered it liquid. The water produced follows again the general law, and becomes a conductor of heat.

§ LXXIV. Therefore, if a body of a certain temperature be brought into contact with ice, it will impart to the ice its own caloric, till it has deſcended to the temperature of the ice itſelf; and we ſhall ſee that only as much of the ice returns to the ſtate of water as the caloric, which it had imbibed, could liquify. This, however, is that portion of caloric which had raiſed the body from the temperature of the ice to that which it poſſeſſed previous to the experiment, and which we have denominated ſpecific heat. Moreover, ſince equal quantities of caloric ought to liquify equal quantities of ice, it follows, that the ſpecific heat of bodies, under like circumſtances, is in a direct ratio of the quantities of ice which they can liquify when brought into contact.

§ LXXV. From the foregoing obſervations we may draw the following concluſions:

1. If equal quantities of the ſame body, at the ſame temperature, come ſeverally into contact with ice, then equal quantities of ice will be changed into the liquid ſtate of water, and ſuch bodies will deſcend to the temperature of the ice.

2. If unequal quantities of the ſame body be treated in a ſimilar manner, then the quantities of the ice liquified will be in a direct ratio of the quantities of the body.

3. But, if equal quantities of different bodies be treated in this way, then the quantities of the ice liquified will be in a direct ratio of the quantities of caloric which thoſe bodies have loſt, or, in other words, they will be in a direct ratio of the quantities of caloric which cauſed thoſe bodies to aſcend from the temperature of the ice to that which they

poſſeſſed at the beginning of the experiment, and, therefore, as the maſſes of the bodies were equal, they will be in a direct ratio of their ſpecific heat, and in a direct ratio of their own capacities for caloric.

Theſe experiments not only demonſtrate, that different bodies, in reality, poſſeſs different capacities for caloric; but they likewiſe ſhew us the means by which we are enabled to meaſure the relative quantities which they contain.

§ LXXVI. Heat and cold, therefore, with reſpect to our ſenſes, are diſtinguiſhed by thoſe perceptions which are the effect either of an augmentation, or diminution of caloric, in the animal body, whenever we approach an object whoſe temperature is either higher or lower than that which we ourſelves poſſeſs. But, ſince this and all other corporeal ſenſations depend, in a great meaſure, upon habit and education, it acts more or leſs ſtrongly in different perſons, either from cauſes not yet ſufficiently aſcertained, or, becauſe ſimilar ſenſations had been felt before. The ſenſation of heat and cold is not, therefore, always a juſt criterion of the true ſtate of a body as to temperature.

§ LXXVII. Whenever the degree of temperature is ſo high as to excite in us a ſenſation of pain, we term it hot. A body is ſaid to be of a white heat, when caloric and light is rapidly diſengaged, and the temperature of ſuch body is that of candeſcence. A gazeous body, when ignited, produces flame.

Incandeſcence and flame, therefore, are obſerved in the rapid diſengagement of caloric and light. The firſt effect of this diſengagement is inflammation; and theſe phenomena, taken collectively, excite in us that idea which is expreſſed by the word fire.

§ LXXVIII. Among the various ſtates of heat, it is neceſſary that we ſhould conſider caloric in two points of view.—Firſt, as it elevates bodies above the temperature of the ſurrounding medium, where it is known by the term ſenſible heat, and which we can meaſure either by a common thermometer or by Wedgwood's pyrometer. Secondly, the whole quantity of caloric exiſting in a body in chemical union, where it is known by the term abſolute heat, the quantity of which is aſcertained by the calorimiter of La Place.

§ LXXIX. From the principal laws which caloric follows in its combination with other bodies, and from the properties already recited, many phenomena may be explained which occur in the chemical ſolution of bodies, and in which caloric is the principal agent. Thus:

1. Why two ſolid bodies cannot mutually diſſolve each other; and why it is neceſſary, for that purpoſe, that one of them, at leaſt, ſhould be in a fluid ſtate.

2. Why, in moſt combinations of ſolids with fluids, caloric promotes ſolution.

3. Why the contrary happens in ſolutions of æriform bodies in liquids.

4. Why the combination of two ſolid or two fluid bodies, or the combination of one fluid with one ſolid, produces a body which is either ſolid or fluid.

5. What phenomena ought to be produced as to volume, ſpecific gravity, and temperatures.

§ LXXX. In the chemical combination of bodies, however, there occurs another phenomenon of conſiderable importance, which, though it certainly depends upon caloric, yet, in the preſent ſtate of chemiſtry, we are not ſufficiently acquainted with its theory: this is, that the affinity of bodies is greater or leſs after their temperatures have either been increaſed or diminiſhed.

§ LXXXI. Bodies frequently loſe their affinity in an increaſed temperature, and are decompounded; and this phenomenon unfolds the theory of many decompoſitions, which are effected by the aid of diſtillation alone.

IV. OF THE MATTER OF LIGHT.

§ LXXXII. Though Philoſophers are already, in a great meaſure, acquainted with the phyſical properties of light and the laws by which it acts, yet our knowledge, reſpecting its chemical properties and compoſition, is ſtill very limited, and our whole ſcience, on this ſubject, conſiſts merely in the knowledge of a few facts.

§ LXXXIII. Neverthelefs it can be proved by experiments, that the matter of light is a fluid of a peculiar kind, impenetrable and elaſtic; that its gravity, like that of caloric, is not aſcertainable by experiments; that, in common with all other fluids, it poſſeſſes chemical affinities, by which it combines with different ſubſtances, and ſolves compounds, and that it is itſelf ſeparated from its combination.

§ LXXXIV. The moſt remarkable change produced in bodies, in conſequence of their combining with the matter of light, is that of colour; and it is highly probable, that this external property of bodies is chiefly owing to that ſubſtance.

§ LXXXV. The action of the matter of light is moſt conſpicuous upon organized bodies, which are not matured without its influence; and it is alſo certain, that plants derive from light their green colour.

§ LXXXVI. Bodies which produce light, though their temperature be not increaſed, are termed phoſphoreſcent. Several do not obtain this property but when expoſed to light for a conſiderable time, and loſe it again by degrees, when removed into the dark.

§ LXXXVII. The following queries remain to be ſolved reſpecting the matter of light:

1. Is the matter of light a ſimple or compound body?

2. In the firſt caſe, is it a body exiſting *per ſe*, or is it always a conſtituent part of caloric ?

3. In the latter caſe, is caloric a conſtituent part of light ?

4. In either caſe, how far does its co-operation and influence extend in producing the phenomena of heat ?

V. OF THE ATMOSPHERE.

§ LXXXVIII. That gazeous or æriform fluid, which every where inveſts the ſurface of our globe, in which all bodies, exiſting upon that ſurface, are immerſed, and which occupies and fills the intermediate ſpaces, has, by the Philoſophers of every age, been termed the atmoſphere.

§ LXXXIX. Philoſophers, for centuries paſt, had made the atmoſphere an object of their inquiry; and moſt of its phyſical properties have been long ago aſcertained: they had noticed its tranſparency and colour, and had aſcertained its denſity, elaſticity, and gravity. But it is only of late that this fluid, which by the name of air was formerly claſſed among the elements, has been chemically reſolved and ſeparated into its conſtituent parts. The atmoſphere, therefore, comprehends a part of chemiſtry, and as ſuch merits our particular attention.

§ XC. Since the atmoſphere ought to be conſidered as the univerſal laboratory of nature, in which all the chemical changes of bodies, upon the ſurface of the earth, are effected, and in which all bodies reduced to the ſtate of gaz, in conſequence of ſuch changes, are diffuſed, we readily conclude, that the air of the atmoſphere is a very compound body. From its chemical decompoſition, however, it is evident, that moſt of thoſe bodies which we meet with in it are merely adventitious, and variable according to circumſtances, and that the atmoſphere conſiſts, properly, of a very few principles, in which the reſt are diſſolved, as in a common menſtruum. Hence it is neceſſary that we ſhould firſt obtain a knowledge of the true component parts of the atmoſphere.

§ XCI. Let a ſmall portion of mercury be introduced into a glaſs retort, placed in a ſand-bath, and its orifice connected by a glaſs-tube, with a receiver in the hydropneumatic apparatus. The water in the receiver is now raiſed to the height of the water contained in the apparatus, and the bath gradually heated till the mercury nearly boils.

The air of the retort, as well as that of the receiver, will be at firſt ſomewhat rarified by the effect of heat, and the water, contained in the receiver, will be conſequently depreſſed, but the volume of air will ſoon afterwards decreaſe, and the water will again aſcend. The mercury alſo, which at firſt exhibits no material change, begins then to loſe, in ſome meaſure, its fluidity and metallic ſplendour, and becomes a reddiſh ſcaly powder.

§ XCII. After this operation has been continued till neither the air ſuffers a further diminution, nor the mercury is longer changed into ſuch powder, which generally happens in about ten or twelve days, we then find:

1. That the air of the receiver has loſt about one-fifth part of its volume, and that the remainder is not ſo fit for ſupporting flame, or maintaining animal reſpiration, as before:

2. That the mercury, changed into ſuch red powder, is conſiderably augmented in weight; but that the ſpecific gravity of ſuch powder is leſs than that of the mercury.

§ XCIII. The powder thus obtained, being ſeparated from the pure mercury which ſtill adheres to it, is put into a glaſs retort, the orifice of which is attached to Woulfe's apparatus. The retort is now expoſed to a gentle heat, which is gradually increaſed. At firſt the colour of the powder is conſiderably heightened; but afterwards it entirely diſappears, and we obtain the pure metal, and a conſiderable quantity of an æriform fluid.

XCIV. The weight of the mercury, thus acquired, will be leſs than that of the calx employed; but this deficiency is preciſely equal to the weight of the æriform fluid obtained. This gaz is even more fit for the reſpiration of animals and the ſupport of flame than atmoſpheric air itſelf.

XCV. By attentively conſidering theſe experiments, it appears:

1. That in the former operation the atmoſphere has been decompounded; that one part has combined with the mercury, and changed it into a red powder, termed calx of mercury; and that the other part remains unchanged.

2. That, in the latter experiment, a greater degree of heat having been applied, that part of the atmoſphere combined with the mercury is again ſeparated, and both the gaz and the mercury are obtained in a pure ſtate.

§ XCVI. As, from the combination of theſe two gazes, we obtain the former air, we have reaſon to conclude, that the atmoſphere conſiſts of two gazes, of which one is very fit for ſupporting flame and animal reſpiration, the other not at all.

§ XCVII. Each of theſe gazes is compoſed of caloric and a peculiar body, which conſtitutes its baſis. But Chemiſts have not hitherto been able to obtain thoſe two baſes in a ſtate of purity, nor to effect their further decompoſition, for which reaſon they have been conſidered as ſimple bodies: and, as they were before unknown, it became neceſſary to diſtinguiſh them by new terms. Thus the reſpirable part of the atmoſphere has been called oxygen, and the unreſpirable part azot, or nitrogen, and the gazes, formed of theſe baſes and caloric, have been termed oxygen gaz and nitrogen gaz.

§ XCVIII. As the gazeous ſtate of theſe bodies is the ſimpleſt ſtate in which they occur, we ſhall examine them in that ſtate, and firſt of all proceed to treat of the moſt remarkable properties of oxygen gaz.

§ XCIX. The atmoſphere contains oxygen gaz in a proportion of 27 : 100. Its ſpecific gravity, to that of common air, is as 1103 : 1000. A cubic inch weighs 0,50694 of a grain. Water diſſolves but a ſmall quantity of it, and does not from thence ſuffer any change.

§ C. Oxygen gaz is decompoſed by metals, and ſome other bodies, at a higher or lower temperature. They combine with its baſis or oxygen, and form various compounds, the caloric, being at the ſame time diſengaged, paſſes off in the ſtate of ſenſible heat. The operation by which this is effected is termed oxidation; and the compound bodies, thus obtained, are called oxides.

§ CI. But, if the decompoſition be rapidly effected, and the quantity of caloric diſengaged, ſufficient to raiſe the temperature of the bodies to ignition, the proceſs is then termed combuſtion; or, if the bodies be metals, calcination. Thoſe bodies, which, on account of their affinity with oxygen, are capable of burning, are ſaid to be combuſtible bodies.

§ CII. There are but few caſes where the mere contact of a body with oxygen gaz is ſufficient to produce combuſtion; for we are commonly obliged to raiſe the temperature, in order that the bodies may begin their mutual action, which action is ſpontaneouſly continued. Incipient combuſtion is termed accenſion, and bodies, which accend in the common temperature of the atmoſphere, are called pyrophori.

§ CIII. As bodies do not burn in atmoſpheric air but on account of the oxygen gaz contained in it, it follows, that the atmoſphere muſt be neceſſarily reſolved into its conſtituent parts, whenever combuſtion, or oxidation, takes place. The baſis of the oxygen gaz combines with the body in combuſtion, and has its caloric diſengaged; and the nitrogen gaz is left in the atmoſphere unchanged. Beſides, as combuſtion goes on more rapidly when many points of the combuſtible body come into contact with the oxygen gas, it is obvious why a body burns ſo rapidly in pure oxygen gaz, and why agitation promotes combuſtion in common air.

§ CIV. Oxygen gaz is properly that part of the atmoſphere which promotes animal reſpiration. During this function, the oxygen gaz is reſolved into its conſtituent parts. The oxygen partly combines with the blood in the lungs, and gives it its vermillion colour, and partly with the carbon and hydrogen diſengaged from the ſame blood, thus generating carbonic acid and water. At the ſame time, the caloric, which is ſet at liberty, combines with the blood, and quickly diffuſes itſelf throughout the animal body, producing in it that temperature, termed animal heat. The water, the carbonic acid, the nitrogen gaz inſpired, and the ſuperabundant oxygen gaz, are at the ſame time expired from the lungs.

§ CV. From which it is evident:

1. Why an animal, confined in oxygen gaz, lives four or five times longer, than if confined in the ſame quantity of atmoſpheric air; and why, in each of theſe caſes, the gaz is diminiſhed, and at length becomes unfit for reſpiration.

2. Why animal heat is not perceptible in thoſe animals which do not at all reſpire, or, which want but a ſmall quantity of oxygen gaz for reſpiration.

3. Why the ſame cauſe, which renders animal-reſpiration more frequent, always produces a greater degree of animal heat.

§ CVI. Nitrogen gaz is contained in atmoſpheric air in a proportion of 73 : 100. Its ſpecific gravity to that of common air is 985 : 1000; a cubic inch weighs 0,44444 of a grain. It is as little ſoluble in water as oxygen gaz. It is altogether unfit for reſpiration, and the ſupport of flame; for kindled bodies are ſoon extinguiſhed, and animals die almoſt inſtantly on being immerſed in it. It has not the leaſt appearance of an acid, nor is it itſelf combuſtible.

§ CVII. Theſe two gazes, which comprehend the principal parts of the atmoſphere, cannot, indeed, be diſtinguiſhed from each other by the eye; but, as we are taught by experience, that they form themſelves into two ſtrata, which, on account of their ſpecific gravity, reſt upon each other, it follows, that they do not exiſt in the atmoſphere in a ſtate of chemical combination, but in a ſtate of mechanical mixture only.

§ CVIII. The atmoſphere, beſides oxygen and nitrogen gazes, to which it owes its chief properties, conſiſts, as we have ſaid, of other gazeous bodies; but theſe are merely adventitious, and not conſtituent, parts. We ſhall only mention two of them, as being moſt obvious: one is water, and the other, carbonic acid gaz, or fixed air.

§. CIX. All the different gazes, hitherto known, have a greater or leſs affinity with water; they diſſolve it in greater or leſs quantities; and the combination indicates all the marks of a true chemical union. Hence, both the gazes of which the atmoſphere is compoſed, contain, at all times, ſome portion of water, which may be ſeparated, either by means of a body which has a greater affinity with it, or by diminiſhing the temperature.

§ CX. The quantity of water, diſſolved in the atmoſphere, varies according to its temperature. The relative quantity is eſtimated by means of a hygrometer, but the abſolute quantity is aſcertained by means of bodies which poſſeſs a greater affinity for water; as for inſtance, ſome ſalts. According to the celebrated Sauſſure, the greateſt quantity of water which a cubic foot of atmoſpheric air, at the common temperature, can diſſolve is 12 grains.

§ CXI. Since carbonic acid gaz is always generated by animal reſpiration, and diffuſed in the atmoſphere, we may readily conclude, that this gaz muſt neceſſarily form one of its conſtituents in places inhabited by animals. However, it has likewiſe been found, that the atmoſphere, even in ſuch places where animals do not live, contains always a portion of this gaz, though ſomewhat leſs. But, as its proportion in atmoſpheric air is only as about 0.01, it cannot be numbered among the conſtant principles of the atmoſphere.

§ CXII. As atmoſpheric air, on account of the many and great changes which bodies, contained on the ſurface of the earth, undergo, is continually reſolved into its principles, and recompoſed by others, which ſucceed, one would think, that the proportion of oxygen and nitrogen gazes, ought, at different times, and under various circumſtances, to be very different; but experience teaches us, that, in the great maſs of atmoſpheric air, the difference of proportion of theſe two gazes amounts never to more than three, or, at moſt, four parts in a hundred: and nature, amidſt the various means ſhe employs to maintain the harmony of the whole, has ſo wiſely regulated it, that, after all the viciſſitudes which the atmoſphere undergoes, it remains conſtantly in that ſtate which is beſt adapted for the ſupport of animals and fire.

§ CXIII. In order that the proportion of oxygen and nitrogen gazes may be eaſily and readily eſtimated, various inſtruments have been invented, called eudiometers. They are all founded upon the principle of decompoſing common air, by means of a body which has a greater affinity with the oxygen of the oxygen gaz. But of theſe in their place.

VI. OF WATER.

§ CXIV. Water is a tranſparent fluid, colourleſs, very inelaſtic, and void both of taſte and ſmell. It enters not only into the compoſition of moſt bodies of the three kingdoms of nature, but, by itſelf alone, it conſtitutes a phyſical part of the earth, in the form of large maſſes, both ſolid and fluid. Its ſpecific gravity is the criterion of the gravities of all other bodies, and is ſet down as unity. The degrees of temperature at which water paſſes from the ſolid into the fluid ſtate, and from thence into the ſtate of æriform vapour, are likewiſe comparative points of the temperatures of all other bodies.

§ CXV. Though water may exiſt under a triple form, and in that caſe poſſeſs various phyſical properties, yet, this circumſtance, chemically conſidered, produces no other effect than that which the diffuſion of caloric produces in all bodies.

§ CXVI. Water, as generally met with, and even rain, is not ſtrictly pure, but impregnated with various heterogeneous particles. It is requiſite, therefore, that it ſhould be purified before it is uſed for experiment. This is effected by ſimple diſtillation; for thus the ſolid particles are left behind, moſt of the volatile parts paſs off in the form of air, and pure water flows into the receiver. Water, obtained by a proceſs of this kind, has not ſuffered the leaſt decompoſition, and is termed ſimple diſtilled water.

§ CXVII. Water, till very lately, was conſidered by natural philoſophers as a ſimple body, and claſſed amongſt the elements. But within theſe few years we have diſcovered the means of reſolving this body into its conſtituent parts, and of recompoſing it; and it can now be demonſtrated, as well by analyſis as ſynthesis, that water is a compound body conſiſting of two principles.

§ CXVIII. Let pure water be affuſed in the pneumatic apparatus upon iron filings, and kept at reſt. After ſome time, the iron will begin to loſe its metallic ſplendour, and be changed into a fine black powder, and a conſiderable quantity of a gazeous fluid will eſcape from the mixture. At length, when all the iron is thus changed into black powder, we ſhall find:

1. That the iron has increaſed in weight.

2. That the quantity of water is diminiſhed.

3. That the ſum of the additional weight of the iron, and of the weight of the gazeous fluid obtained, is preciſely equal to the weight of the water loſt.

§. CXIX. Let a luted iron tube be placed horizontally in an air furnace, and let a glaſs retort containing a certain quantity of water be attached to one of its extremities, and to the other extremity the hydropneumatic apparatus. The iron tube being now ignited, and the water, contained in the glaſs retort, heated at the ſame time to ebullition, aqueous vapours are forced to paſs through the red hot tube; and water, beſides a great quantity of gaz, will be obtained in the receivers.

§ CXX. When the water has paſſed in this manner through the iron tube, in the form of vapours, and after the apparatus has been cooled, we ſhall find:

1. That the internal ſurface of the iron tube is oxided, and, conſequently, that the weight of the tube has been increaſed.

2. That the quantity of water which has flowed into the receiver is leſs than that previouſly contained in the retort.

3. That the ſum of the weight of the gaz acquired, and of the increaſed weight of the iron, is preciſely equal to the weight loſt by the water.

§ CXXI. In each of theſe experiments, the water is decompounded. The iron, combining with one of its principles, is reduced to an oxide, and the other principle combines with caloric, and forms a gazeous fluid. Since the change which the iron undergoes in thoſe experiments is a true oxidation, we may readily conclude, that oxygen is one of the conſtituents of water.

§ CXXII. On examining the æriform fluid obtained, we find that it poſſeſſes the following properties:

1. It is much lighter than atmoſpheric air; its ſpecific gravity to that of the atmoſphere being as 1000 to 15000, and a cubic inch of it weighs 0.07539, of a grain.

2. It has a peculiar ungrateful ſmell, and is totally unfit for animal reſpiration, and the ſupport of flame.

3. It is itſelf a combuſtible body, and may be inflamed in contact with oxygen gaz.

§ CXXIII. As this gaz is diſtinguiſhed from all others on account of its property of being inflammable, it has been termed inflammable air. But, as its baſis, which becomes gaz in conſequence of combining with caloric, conſtitutes the other principle of water, modern Chemiſts have termed it hydrogen.

§ CXXIV. As water can be reſolved into its two principles, not only by the foregoing experiments, but by a great number of others, ſo it can likewiſe be obtained again from thoſe principles by ſyntheſis; for, whenever hydrogen gaz is burned in oxygen gaz, their baſes combine, and form pure water; and, if this proceſs be performed in a cloſe veſſel, we find that the weight of the water obtained is preciſely equal to the weight of the two gazes employed.

§ CXXV. Water, therefore, conſiſts of two principles, viz. of oxygen, or the baſis of oxygen gaz, and of hydrogen, or the baſis of inflammable air, combined by true chemical union. According to the experiments hitherto made, both by ſyntheſis and analyſis, water contains oxygen in a proportion of about 6 : 1 of hydrogen, or equal to 85.663: 14.337 : that is, 100 grains of water contain about 86 grains of oxygen, and 14 grains of hydrogen. Or, as to volume, two parts of hydrogen gaz require about one part of oxygen for combuſtion; and the water, thus produced, occupies about 1–2000th part of that volume.

§ CXXVI. If hydrogen gaz be mixed with oxygen gaz, previous to their being burned, the combuſtion will be inſtantaneous; and, on account of the extraordinary diminution of volume, which takes place immediately, a vacuum is produced, into which the ſurrounding atmoſphere, ſuddenly ruſhing, cauſes a ſtrong report, which will be the more violent by how much more the oxygen gaz is purer, and by how much more a due proportion of each gaz has been obſerved.

§ CXXVII. As the combuſtion of inflammable air in atmoſpheric air is only in a direct ratio of the quantity of oxygen gaz which it contains, inflammable air has been made uſe of as an eudiometer. To this end, equal parts of atmoſpheric and of inflammable air are introduced into a graduated glaſs tube, cloſed by means of a cock. The gaz, thus mixed, is then inflamed by the electric ſpark, and the cock of the tube, immerſed in water, is opened. The water which thus enters the tube indicates the volume of the vacuum, and, conſequently, the proportionate quantity of oxygen gaz.

§ CXXVIII. From this knowledge of the principles of water, we may explain the reaſons:

1. Why the combuſtion of bodies, which contain a great deal of hydrogen, ſuch, for inſtance, as fat, oil, ſpirit of wine, &c. is at all times productive of water; and why it happens that the weight of the water, thus obtained, exceeds oftentimes the weight of the combuſtible body itſelf.

2. Why a ſmall quantity of water ſprinkled upon ſuch bodies, when burning, promotes combuſtion.

3. How oxygen gaz is diffuſed in the atmoſphere in conſequence of the frequent decompoſitions of water which take place on the ſurface of the earth.

4. How, in ſome very rare caſes, this decompoſition of water produces inflammable air, as is obſervable in marſhes and ſtagnated waters: whence ignes fatui, ſtreamers, &c.

5. How this inflammable air, on account of its levity, is carried into the higher regions of the atmoſphere, where, on the electric fluid forming an equilibrium, it is inflamed and reduced to water, cauſing the phenomena of lightning, thunder, and partly of rain.

§ CXXIX. Although it has not been demonſtrated, yet it is very probable, that a part of the oxygen gaz inſpired combines with the hydrogen diſengaged in the lungs, and forms water; whence the air which we expire is commonly moiſt.

THE MINERAL KINGDOM.

§ CXXX. The ſubſtances of the mineral kingdom, conſidered with reſpect to their chemical properties, may be properly divided into four claſſes: 1. Salts; 2. Earths; 3. Inflammable Bodies; and 4. Metals.

VII. OF SALTS IN GENERAL.

§ CXXXI. Since in the three kingdoms of nature there are bodies which, from the great ſimilarity of their properties, are claſſed among the ſalts, therefore, before we proceed to treat of the ſalts of the mineral kingdom excluſively, we ſhall make ſome general obſervations equally applicable to thoſe of the animal and vegetable kingdoms.

§ CXXXII. Although it be eaſy, even to thoſe who are but imperfectly ſkilled in chemiſtry, to diſtinguiſh ſalts from other bodies, yet it is very difficult, nay, next to impoſſible, to give a definition of a ſalt which may not be applicable to any other ſubſtance. A definition of this claſs of bodies, however, ſeems to depend upon the agreement of the following properties, which every ſalt poſſeſſes in a greater or leſs degree:

§ CXXXIII. All ſalts are ſoluble in pure water, although they greatly differ in ſolubility, which is determined by the proportionate quantity of boiling water required to diſſolve the ſalt. Thus ſome kinds of ſalt require no leſs than 1000 parts of water for complete ſolution; others, on the contrary, require but half their weight of water. From theſe different degrees of ſolubility, ſome Philoſophers have attempted to point out the limits between ſalts and earths, and, therefore, conſider ſuch bodies only as ſalts which are ſoluble in 200 parts of boiling water. Bergmann ſtates this limit at 1000 parts.

§ CXXXIV. Moſt ſalts excite that ſenſation upon the tongue which is termed ſavour; but, as this ſenſation depends, in ſome meaſure, upon the ſolubility of the ſalt in the ſaliva, therefore ſalts are more ſavoury as they are more ſoluble. In ſuch as do not diſſolve but with the greateſt difficulty, ſapidity is ſcarcely perceptible.

§ CXXXV. Many ſalts, after having been diſſolved in water, and the ſolution evaporated, may be again obtained pure, and in a certain and determinate cryſtalline form. Such as are more readily diſſolved in hot than in cold water are cryſtallized by cooling the lixivium; but ſuch as aſſume the form of cryſtals, under no circumſtance whatſoever are ſaid to be uncryſtallizable. There are many ſalts which cannot be exhibited in a ſolid form; and others are only pure when in the ſtate of gaz.

§ CXXXVI. Incombuſtibility has been conſidered by ſome Chemiſts as a property common to all ſalts, becauſe moſt ſalts, previous to combuſtion, muſt be reſolved into their component parts; and theſe parts alone are burned, and not the ſalts themſelves. But this obſervation does not generally hold good; for ſome ſalts burn by entering into combination with a ſuperabundant portion of oxygen: but this combuſtion goes on ſlowly, and without producing flame.

§ CXXXVII. Salts, compared with other bodies, poſſeſs the greateſt number of affinities, and are, therefore, continually employed in analyſis. Hence the ancient Chemiſts diſtinguiſhed them excluſively by the name of ſolvents.

§ CXXXVIII. Salts, with reſpect to their chemical properties, are divided into two claſſes; into acid ſalts, or acids, and into alkaline ſalts, or alkalis; and from the mutual combination of theſe two ariſes a third claſs, viz. that of neutral ſalts.

§ CXXXIX. Acids poſſeſs the following characteriſtic properties:

1. A peculiar taſte, termed acid.

2. They change the colour of blue vegetable juices red.

3. They readily combine with alkalis, earths, and metals, with which they form neutral ſalts.

§ CXL. Acids, according to the kingdom of nature, in which they are moſt commonly found, are divided into mineral, vegetable, and animal.

CXLI. The mineral acids with which we are at preſent acquainted amount to ten: 1. ſulphuric or vitriolic acid; 2. nitric acid; 3. muriatic acid; 4.

carbonic acid; 5. boracic acid; 6. fluoric acid; 7. ſuccinic acid; 8. arſenic acid; 9. molybdic acid; 10. tungſtic acid.

The vegetable acids are likewiſe ten:

1. acetic acid; 2. oxalic acid, or acid of ſugar; 3. tartareous; 4. gallic; 5. citric; 6. malic; 7. benzoic; 8. pyroligneous; 9. pyromucous; 10. camphoric.

Of animal acids there are eight:

1. Phoſphoric; 2. lactic; 3. ſacholactic; 4. formic; 5. ſebacic; 6. pruſſic; 7. bombic; 8. lithic.

§ CXLII. Formerly, acids were either conſidered as ſimple bodies, or various hypotheſes were advanced reſpecting their origin and compoſition. At preſent, however, it is proved by experiment, that every acid conſiſts of a peculiar body, combined with the baſis of oxygen gaz, and which has thence received the name of oxygen. The bodies which form the other conſtituent of acids are termed baſes, or radicals of acids, and may be either ſimple or compound.

§ CXLIII. All acids, therefore, ariſe either from combuſtion or oxidation; and ſuch bodies as form acids during theſe operations are denominated acidifiable baſes.

§ CXLIV. If an acidifiable baſis be perfectly ſaturated with oxygen, the acid, thus produced, is ſaid to be perfect; but if the baſis predominate, the acid is ſaid to be imperfect. Modern Chemiſts diſtinguiſh the former by the ſyllable *ic*, and the latter by the ſyllable *ous;* thus we have the nitric and nitrous acid, acetic and acetous acid, &c. Finally, if oxygen be combined with the acidifiable baſis in ſo ſmall a proportion, that the compound body does not indicate any acid property, it is ſimply called an oxide, (§ C.)

There are ſome caſes where an acid is capable of combining with an exceſs of oxygen, in which caſes it is ſaid to be oxygenated.

§ CXLV. The general properties of pure alkalis are:

1. That they poſſeſs a peculiar cauſtic, or burning taſte, termed alkaline.

2. That they change the blue juices of vegetables green; the yellow infuſion of turmerick brown; and the red infuſion of fernambuck violet.

3. That, combining with acids, they form neutral ſalts.

§ CXLVI. Alkalis are either fixed, that is, they are not reduced to the ſtate of gaz by the moſt intenſe heat which we can produce; or, they are volatile, that is, the common temperature is almoſt ſufficient to change their ſtate of aggregation. We have two of the former, pot-aſh, or fixed vegetable alkali, and ſoda, or fixed mineral alkali: of the latter, we are only acquainted with one, ammoniac, or the volatile alkali.

§ CXLVII. Alkalis are ſeldom pure, for they are uſually combined with carbonic acid, in the form of neutral ſalts. In this ſtate they are termed mild, common, or ærated alkalis, to diſtinguiſh them from cauſtic or pure alkalis.

§ CXLVIII. The volatile alkali is found to be a compound of hydrogen and nitrogen; but, as to the principles of the fixed alkalis, nothing but conjectures have been hitherto advanced; the moſt probable of which is, that nitrogen forms one of their conſtituent parts.

§ CXLIX. The characteriſtic properties of neutral ſalts are:

1. A peculiar taſte, which is neither acid nor alkaline, generally termed ſaline.
2. They do not change the colour of blue vegetable juices.

§ CL. Neutral ſalts are ſub-divided into genera, according to their different baſes. Hence we have alkaline ſalts, earthly and metallic ſalts. The former are compoſed of an acid and an alkali; but the latter are combinations of an acid with an earth or a metal.

§ CLI. As the neutral ſalts we have mentioned are capable of containing oxygen in a greater or leſs proportion, and as under ſuch circumſtances they will indicate properties very different, there naturally follows an important diviſion. Modern Chemiſts diſtinguiſh the former, or thoſe containing the greater proportion of oxygen, by the ſyllable *ate*, and the latter by the ſyllable *ite*: thus we have ſulphates and ſulphites, acetates and acetites, &c.

§ CLII. There are alſo many neutral ſalts which take up a ſuperabundant portion of acid during cryſtallization. Theſe are termed acidulous neutral ſalts.

VIII. OF NITRATE OF POTASH.

§ CLIII. Nitre, ſalt-petre, or nitrate of pot-aſh, is a neutral ſalt, formed by the combination of a peculiar acid and pot-aſh, or the fixed vegetable alkali. It is found in the fiſſures of the lime-ſtone hills, near Molfetta, in the kingdom of Naples, in various waters, and even in rain; likewiſe in the freſh juices of many plants, ſuch as the heliotrope, pellitory, tobacco, and others. It is produced ſpontaneouſly wherever its alkaline baſis is expoſed to a free current of air, and to the exhalations of putreſcent vegetable and animal matter; as on damp walls, rubbiſh, the ordure of ſtables, dung-hills, &c. In Spain, the Eaſt-Indies, and near Lima, it is generated upon commons and uncultivated ground; nay, it is even aſſerted, that, in the ſouthern regions of Spain, ſalt-petre is found in the duſt of the high-roads.

§ CLIV. Nitre is employed at preſent for ſo many different purpoſes, and in ſuch great quantities, that the nitre, naturally formed, is by no means adequate to ſupply the demand. Hence it became neceſſary to conſider the means of increaſing and accelerating its production. This was effected by an artificial concurrence of the materials neceſſary for its formation; and this conſtitutes the principle upon which the nitre-manufactories in different countries are eſtabliſhed.

§ CLV. In Germany we have adopted the following method: we mix different kinds of light earth, lime, marl, putrefying and putrefied animal and vegetable matter, dung, rubbiſh, common aſhes, aſhes of ſoap-manufactories, &c. This mixture, which is termed the mother-earth, is formed into pyramids of about ſix feet high, defended by a roof againſt rain and the beams of the ſun, but at the ſame time every where expoſed to a free current of air. In this ſtate the heaps are continually kept moiſt by ſprinkling water upon them; and in the courſe of a year they are three or four times removed; and after the earth has been properly wrought, it is laid up as before. In a few months the ſalt effloreſces upon the ſurface of the heaps; but this formation of nitre extends only to the depth of a few inches. In about three years, however, the earth is ſufficiently impregnated with the ſalt to pay for the trouble of boiling.

§ CLVI. The nitre obtained by the lixiviation of the mother-earth is by no means pure; for the nitric acid, beſide pot-aſh, contains a ſolution of lime, magneſia, and ammoniac. The nitre is likewiſe mixed with the ſalts produced by the combination of the muriatic acid with the alkaline baſes. To ſeparate the nitre from thoſe bodies, a ſolution of pure pot-aſh in water is added to the lixivium of nitre, till no further precipitation takes place. The lixivium is then filtrated and evaporated, to obtain it in the ſtate of cryſtals or crude nitre. The lixivium which remains is termed the mother water of ſaltpetre factories, and is uſed for ſprinkling the heaps above-mentioned.

§ CLVII. Pot-aſh, on account of its greater affinity for the nitric acid, diſengages the ammoniac and the ſeveral earths, and, by combining with it, forms true nitre. On this occaſion the ammoniac comes over in the ſtate of gaz; the precipitate is a mild calcareous earth mixed with a ſmall portion of magneſia, and known by the name of nitrate of magneſia.

§ CLVIII. The vegetable alkali which is added alſo decompounds the neutral muriates formed at the ſame time with the nitre, changing them into muriate of pot-aſh, which cryſtallizes along with the crude nitre, and remains in a ſtate of mechanical mixture with it. To purify the nitre alſo from this ſubſtance, it is thrown into a tub, furniſhed near the bottom with a cock. You then affuſe pure cold water nearly to the height of the nitre, that you may conveniently ſtir it, which operation is continued till the ſalt begins to loſe its foul yellow colour, when the water is drawn off by the cock. The reaſon is, that the muriate of pot-aſh is much more ſoluble in water than the nitre. In this operation, however, the quantity of water ſhould be neither too great, nor remain too long in the veſſel; for, in either caſe, we ſhall experience a conſiderable loſs of nitre;

and it is for this reaſon that the nitre is never entirely ſeparated.

§ CLIX. This nitre is removed to another part of the manufactory to be purified from the ſmall quantity of muriate of pot-aſh with which it is mixed, as well as from the colouring matter. For this purpoſe it is diſſolved in water; the ſolution is filtrated and evaporated in a copper veſſel; and the ſaline film, floating on the lixivium, is taken away, till a ſmall quantity of the hot liquor, when poured into a veſſel and cooled, ſhoots into cryſtals, or till ſuch a time as experience points out. The lixivium is then gradually introduced into a wooden veſſel, and ſet aſide to cryſtallize. That part of the lixivium which remains is treated in the ſame manner, either by itſelf, or with a new portion of lixivium, and this proceſs is repeated till the lixivium becomes at length brown and thick, when it is termed the mother-water of the ſecond boiling.

§ CLX. This purification of nitre depends upon the different properties of thoſe two ſalts when diſſolved in water; for the nitre is diſſolved in much greater quantities in hot than cold water; whereas muriate of pot-aſh is diſſolved in nearly the ſame quantity, both of hot and cold water; the nitre is not therefore affected at the commencement of the evaporation of the water, becauſe the loſs of water is balanced by the increaſe of heat; but the muriate of pot-aſh, on the contrary, is greatly affected by this loſs, and ſhoots into cryſtals upon the ſurface of the lixivium. The mother-water which remains contains, beſide the extractive colouring matter, a ſmall quantity of nitre, and a great deal of muriate of pot-aſh.

§ CLXI. The nitre afforded by this depuration, though almoſt entirely freed from the muriate of pot-aſh, and the colouring matter, is ſtill further to be purified from the laſt extractive particles, and from the ſuperabundant carbonate of pot-aſh. To this end the nitre is again diſſolved in water, which ſolution, when poured into ſmaller copper veſſels, is heated to ebullition. Some quick lime is then thrown in, which cauſes a pellicle; this is immediately removed, and the lixivium is ſuffered to cryſtallize in the uſual manner. The quicklime not only combines with the colouring matter which had remained, but alſo produces cauſticity in the carbonate of pot-aſh, or mild alkali, which, in that ſtate, is no longer capable of cryſtallizing with the nitre, and conſequently remains in the mother-water. The nitre thus obtained is that uſed in commerce.

§ CLXII. As the nitre, uſed for chemical purpoſes, ought to be perfectly pure, the following method may be employed for that purpoſe:—Diſſolve nitre of the ſhops in pure boiling water, nearly to the point of ſaturation; ſtrain the ſolution while hot, and add a few drops of cauſtic pot-aſh. If no precipitation takes place, the lixivium may be cryſtallized; on the contrary, add pot-aſh till the precipitation ceaſes. The lixivium is then boiled once more, ſtrained, and cryſtallized. The firſt cryſtals afford the pureſt nitre. The lixivium which remains, on being evaporated and cooled, depoſits a few more cryſtals, and what nitrate of pot-aſh the nitre may have contained remains in the laſt lixivium.

§ CLXIII. This very pure nitre appears in the form of hollow priſmatic hexaëdral cryſtals, with pyramidical hexaëdral extremities, which break into pieces on the application of a gentle heat, but remain entire in the atmoſphere. It has a cooling taſte, and produces a conſiderable degree of cold, during its ſolution in water. It is ſoluble in ſeven parts of cold, and one of boiling water. The cryſtals fuſe at a moderate heat, on account of the quantity of their water of cryſtallization. If nitre be kept in the fire till its water is nearly diſſipated, and be then poured into ſmall papers upon a ſtone table, we obtain what is termed tabulated nitre, which merely differs from the former nitre in containing leſs water.

§ CLXIV. If the fuſion of nitre be protracted to candeſcence, it will be decompoſed, for its acid eſcapes in the form of oxygen and nitrogen gazes, and its cauſtic or pure alkali remains. If this operation be performed in a luted earthen or glaſs retort, we ſhall obtain 12000 cubic inches of oxygen gaz from one pound of nitre, and the oxygen gaz will contain but a very ſmall quantity of nitrogen gaz.

§ CLXV. To obtain pure nitric acid, one part of concentrated ſulphuric acid is added to two parts of nitre. The ſulphuric acid having a greater affinity with pot-aſh than the nitric acid, the latter is expelled; and, becauſe it combines with caloric, paſſes off in the ſtate of gaz, termed nitrous acid gaz. This gaz may be obtained over mercury. It is perfectly tranſparent, but is readily abſorbed by water, with which it forms liquid nitric acid. The combination of ſulphuric acid and pot aſh produces a neutral ſalt, viz. ſulphate of pot-aſh.

§ CLXVI. To obtain this liquid nitric acid in greater quantity for chemical purpoſes, one part of ſulphuric acid is added to two, or rather three parts of the pureſt nitre, in a glaſs retort, on the ſand-bath, and Woulfe's bottles, containing a certain quantity of pure water, except the firſt bottle, are applied. The firſt nitrous acid gaz which comes over, both ſpontaneouſly and on account of the heat which is gradually applied, combines with the water of cryſtallization of the nitre, and with the water contained in the ſulphuric acid, and is collected in the firſt or empty bottle, in the form of a yellow fuming liquor, commonly called Glauber's fuming ſpirit of nitre. The remainder of the nitrous acid gaz, however, is diſſolved in the water of the other receivers, and becomes nitric acid.—Laſtly, we ſhall find that the retort contains a white ſaline reſidue, viz. ſulphate of pot-aſh, which is purified by ſolution in water and cryſtallization.

§ CLXVII. Nitre is decompounded in the ſame manner by ſulphate or vitriol of iron. Mix iron with an equal quantity of calcined ſulphate of iron, which put into an earthen or glaſs luted retort, and proceed as before, except that the heat may be ſomewhat increaſed. Thus you obtain fuming ſpirit of nitre, and a reſidue conſiſting of a mixture of ſulphate of pot-aſh and oxide of iron. On account of the greater affinity of the ſulphuric acid with the pot-aſh, both the vitriol and the nitre are decompoſed; for the ſulphuric acid combines with the pot-aſh, the nitric acid eſcapes in the form of gaz, and the iron remains in the ſame ſtate in which it exiſted in the vitriol, viz. in the ſtate of oxide. It is thus generally known by the name of colcothar of vitriol, which is uſed for poliſhing ſteel, &c.

§ CLXVIII. A decompoſition of nitre is likewiſe effected by alumine, ſiliceous earth, and, eſpecially, clay. If to this end one part of nitre be mixed with two parts of pure clay in powder, and diſtilled in an earthen retort over a ſtrong fire, fuming ſpirit of nitre will paſs into the receiver, and a ſemivitrified ſubſtance, produced by the combination of the clay with the cauſtic alkali, and generally mixed with a ſmall portion of ſulphate of pot-aſh, will remain in the retort. The theory of this proceſs is as yet obſcure, and Chemiſts entertain various opinions upon it. Some aſcribe the decompoſition of nitre to the ſulphuric acid contained in the clay; others, apparently with more truth, explain it by the affinity of the clay for the pot-aſh at this temperature.

§ CLXIX. Fuming nitrous acid, when mixed with water, produces a very conſiderable degree of heat, and at the ſame time a cloud of red vapours is emitted, which, being collected over water, in the pneumatic apparatus, furniſh a tranſparent colourleſs gaz, termed nitrous gaz. The liquor which remains becomes green, on the addition of more water, blue, and, at length, colourleſs. In this ſtate it is generally known by the name of Aqua fortis; but its proper name is nitric acid.

§ CLXX. The aqua fortis of the ſhops is prepared according to the two latter methods, with this difference, that as much water is previouſly introduced into the receiver as may ſufficiently dilute the nitrous acid. That which is leſs diluted with water is called double aqua fortis.

§ CLXXI. Nitric acids, eſpecially thoſe obtained by the two former methods, are always mixed with a ſmall portion of ſulphuric, and, perhaps, muriatic acid. It is cuſtomary, therefore, in order to have it pure, to re-diſtil it upon freſh nitre. Experience has taught us, however, that this mode of purifying the nitric acid does not fully anſwer; for ſome parts of the ſulphuric acid will always come over at the ſame time.

§ CLXXII. By purſuing the following method, it may be obtained perfectly free from ſulphuric acid: a ſmall piece of very pure ſilver is thrown into the hot nitric acid, which immediately becomes turbid, aſſumes a milky colour, and gradually depoſits a white powder. When the acid recovers its limpidity you add another particle of ſilver, and this operation is continued till the laſt particle thrown in leaves the acid perfectly clear. Or a ſolution of ſilver, in very pure nitric acid, is added drop by drop to the acid to be purified, till the precipitation ceaſes. The ſilver, having a greater affinity for the ſulphuric and muriatic acids than for the nitric acid, combines with them, and forms inſoluble ſalts. A white powder or metallic ſalt is, therefore, always formed and precipitated, as long as the leaſt quantity of either of thoſe acids is preſent. At length, the acid is poured off from the precipitated powder, and you obtain pure aqua fortis, uſed by refiners to ſeparate gold from ſilver. For chemical purpoſes, it ought, moreover, to be freed from the nitrate of ſilver which it contains. This is effected by ſlow diſtillation, but not continued to dryneſs, for a ſmall quantity of the liquor ſhould be left in the retort, leſt ſome of the nitrate of ſilver be carried over into the receiver.

§ CLXXIII. Fuming ſpirit of nitre inſtantly diſſolves ice and ſnow, cauſing a conſiderable diminution of temperature. Pure nitric acid is never ſeen in a ſolid form; but aqua fortis, whoſe ſpecific gravity was 418, has been frozen in a temperature of $2\frac{3}{4}°$ of Fahrenheit's thermometer.

§ CLXXIV. Fuming ſpirit of nitre combines with almoſt all etherial, fat, and empyreumatic oils, and forms a tenacious ſubreſinous ſubſtance, which has more or leſs the odour of muſk. This combination takes place in an inſtant, and is always attended by a diſengagement of nitrous gaz, and of ſuch a quantity of caloric as oftentimes to cauſe a ſudden inflammation, eſpecially with etherial oils heavier than water. When combined with empyreumatic oils, extracted from heavy wood, for inſtance, guaiacum, we obtain a light and porous maſs, called Fungus philoſophicus. Theſe inflammations will ſucceed the better if the ſpirit of nitre be mixed with a ſmall portion of ſulphuric acid.

§ CLXXV. The action of the nitric acid upon metals always produces nitrous gaz. On this occaſion the nitric acid is decompoſed; part of its oxygen, combining with the metals, forms metallic oxides, which are either diſſolved in the remaining nitric acid, or precipitated; and the acid which remains, being thus in a great meaſure deprived of its oxygen, becomes nitrous gaz, which is, therefore, a true oxide of the baſis of the nitric acid.

§ CLXXVI. Whenever acidifiable baſes of either of the three kingdoms are treated with nitric acid, a ſimilar decompoſition takes place. A great quantity of nitrous gaz is always developed, and thoſe baſes, by combining with oxygen, form new acids, or at leaſt oxides.

§ CLXXVII. The nitrous gaz obtained by the preceding methods has the following properties:

1. Its ſpecific gravity to that of atmoſpheric air is 1.195 : 1000. A cubic inch* weighs 0.54690 parts

---

* I think it proper to obſerve that the Author on this, and all other occaſions, had uſed French weight and meaſure. T.

of a grain; it is totally unfit for animal reſpiration and combuſtion; it is not diſſolved in water, nor does it indicate the leaſt property of an acid.

2. The mixture of one part of nitrous gaz, and four parts of oxygen gaz, produces red vapours; becauſe the baſes of each gaz mutually combine, and form nitrous acid; and the ſuperabundant caloric eſcapes in the ſtate of ſenſible heat. If this operation be inſtituted over mercury, the nitric acid recently formed will remain upon its ſurface in the form of nitrous acid gaz; but, if made over water, it is immediately abſorbed by it.

§ CLXXVIII. As azotic gaz does not combine with nitrous gaz, but remains behind, when mixed with it, as in the preceding experiment, Dr. Prieſtly employed nitrous gaz with ſucceſs for aſcertaining the proportionate quantity of oxygen gaz in atmoſpheric air. To this end, equal parts of nitrous gaz and of atmoſpheric air are mixed over water, and the greater or leſs diminution of volume of the gazes determines the relative quality of the air examined. But, in order that thoſe experiments may always lead to the ſame reſults, they ought to be inſtituted by means of an inſtrument invented for that purpoſe by the celebrated Fontana, termed Fontana's eudiometer. The application of this inſtrument requires, however, great nicety.

§ CLXXIX. Nitric acid conſiſts, therefore, of the baſis of nitrous gaz and of oxygen; and, according to Lavoiſier, 100 parts of nitric acid conſiſt of 64 parts of the baſis of nitrous gaz, and 36 of oxygen, But even the baſis of nitrous gaz is an oxide, being compoſed of oxygen and a particular baſis, nitrogen, which will be demonſtrated by the following experiments.

§ CLXXX. Mix 7 parts of oxygen gaz, by meaſure, with 3 parts, of nitrogen gaz, in a glaſs tube, over water, and paſs a continued ſtream of electric ſparks through it. After ſome time we perceive that the gazes diminiſh, and are entirely abſorbed by the water, which, being then examined, is found to contain nitric acid. The baſes of thoſe gazes, therefore, mutually combine, and form nitric acid.

§ CLXXXI. If a pyrophorus or a ſmall portion of ſulphuret of alkali be put into a veſſel filled with nitrous gaz, the gaz is gradually diminiſhed, and at length pure nitrogen gaz remains. In this caſe the oxygen of the nitrous gaz combines with the inflammable body, and thus the nitrogen gaz is left in a free ſtate.

§ CLXXXII. From theſe two experiments chiefly, and a great number of others more complex, it is evident that azot, or nitrogen, conſtitutes the baſis of nitric acid, which obtains its acid property from its combination with oxygen. It appears from the experiments of Meſſrs. Lavoiſier and Cavendiſh, that 20½ parts of nitrogen, combined with 43½ parts of oxygen, form nitrous gaz, which, when ſuperadded with 36 parts of oxygen, forms nitric acid; but, if only half that portion be added, nitrous acid.

§ CLXXXIII. The fuming ſpirit of nitre which we have acquired by the former proceſſes is nitrous acid. If this be heated in a glaſs veſſel till red vapours are no longer emitted, nitric acid will be obtained. Upon the ſame principle, nitrous gaz is expelled on mixing fuming ſpirit of nitre with water, and though the remaining acid be diluted, yet it is true nitric acid.

§ CLXXXIV. From this knowledge of the principles of nitric acid, it is evident:

1. How nitric acid may be formed both in the atmoſphere, and in the caſes adduced, (§ CLIII. CLIV. CLV.) For wherever the atmoſphere contains a conſiderable portion of nitrogen gaz, there nitric acid can be produced, provided thoſe circumſtances occur which are required for the combination of nitrogen and oxygen.

2. Why (§ CLXV.) oxygen and nitrogen gazes are formed when nitre, or its acid, is decompounded by fire alone.

§ CLXXXV. If nitre be treated with inflammable bodies in a fire ſufficiently ſtrong to ignite it, its acid will be decompounded, for the oxygen combines with the inflammable body, and forms a new acid, which, combining with the pot-aſh, produces a new neutral ſalt. The nitrogen comes over either in the form of nitrogen gaz, or, being ſtill united to a ſmall portion of oxygen, as nitrous gaz. This operation is always productive of much heat and light, and is termed detonation.

§ CLXXXVI. Hence, if, to a ſmall portion of nitre fuſed in a crucible, powdered charcoal be added till detonation ceaſes, carbonate of pot-aſh will be obtained, which may be purified from the earthy particles of the charcoal by waſhing. This ſubſtance was formerly termed fixed nitre, and, when diſſolved in water, liquid fixed nitre, or Glauber's univerſal alkaheſt. If the detonation be effected in cloſed veſſels, a ſmall quantity of liquor will run into the receiver, which, for the moſt part, is nothing but water; not unfrequently, however, it is alſo impregnated with nitrous acid, and, ſometimes, a ſmall portion of ammoniac. This is called Clyſſus of nitre. On this occaſion the oxygen of the nitric acid combines with the carbon, and forms carbonic acid, which unites in part with the pot-aſh, forming carbonate of pot-aſh.

§ CLXXXVII. Nitre may not only, as is obvious from the preceding experiments, be reſolved into its conſtituent parts, but may be regenerated by their union. If, to the point of ſaturation, pure nitric acid be added to an aqueous ſolution of pure pot-aſh, and the liquor be then evaporated, cryſtals of the pureſt nitre, generally termed regenerated nitre, will be obtained. From this experiment it is evident, that 100 parts of nitric acid, free from water, require 215 parts of pure pot-aſh for ſaturation; and that 100 parts of the cryſtals of nitre are compoſed of 30 parts of pure acid, 63 of pot-aſh, and 7 of water of cryſtallization.

§ CLXXXVIII. If, in the former experiment, ſome part of the pot-aſh ſhould not be ſaturated, it will remain in the lixivium after cryſtallization has taken place. On the other hand, if the nitric acid ſhould be affuſed beyond the point of ſaturation, in that caſe it will unite with the cryſtals, and form an acidulous neutral ſalt, called acidulous nitrate of pot-aſh, and formerly nitrated nitre.

§ CLXXXIX. The properties of nitre, hitherto mentioned, refer more eſpecially to that ſpecies of neutral ſalts which is compoſed of the nitric acid, and diſtinguiſhed by the name of nitrate of pot-aſh; for we are as yet but imperfectly acquainted with that nitre which contains nitrous acid. We obtain it if the operation (§ CLXIII.) be diſcontinued too ſoon, or be carried on too long (§ CLXIV.) The affinities of the nitrous acid are regulated by peculiar laws; thus, for example, nitrite of pot-aſh is decompounded by the acetic acid, though its affinity for pot-aſh be in other reſpects inferior to that of the nitric acid.

IX. OF NITRATE OF SODA.

§ CXC. From the combination of the nitric acid and the mineral alkali, or ſoda, there ariſes a neutral ſalt, which, on account of the figure of its cryſtals, has obtained the name of cubic, or, more properly, of rhomboidal nitre. Bergmann diſtinguiſhes it by the name of nitrated ſoda, and modern Chemiſts by that of nitrate of ſoda. It has not hitherto been found in a native ſtate, but is always produced, either directly or indirectly, by the artificial combination of its conſtituent parts.

§ CXCI. One hundred parts of pure nitric acid require 165 parts of ſoda for complete ſaturation, and 100 parts of cryſtallized nitrate of ſoda contain 29 parts of acid, 50 of ſoda, and 21 parts of water of cryſtallization.

§ CXCII. The cryſtals of this ſalt are oblique cubes. Its taſte is cooling, and more bitter than that of nitrate of pot-aſh. It requires two parts of water for ſolution, and both cold and boiling water diſſolve it in an almoſt equal proportion. It detonates with inflammable bodies, and, in its other properties, reſembles nitrate of pot-aſh.

X. OF NITRATE OF AMMONIAC.

§ CXCIII. The combination of the nitric acid and ammoniac, or the volatile alkali, produces a neutral ſalt called nitrate of ammoniac, nitrated ammoniac, &c. It is generated ſpontaneouſly in the mother-earth of ſalt-petre manufactories, though but in ſmall quantities. In general it owes its formation, either directly or indirectly, to the artificial union of its conſtituent parts.

§ CXCIV. One hundred parts of nitric acid, deprived of water, are completely ſaturated with 87 parts of pure ammoniac, and 100 parts of nitrate of ammoniac, contain 46 parts acid, 40 ammoniac, and 14 parts of water of cryſtallization.

§ CXCV. If nitrous acid gaz come into contact with ammoniacal gaz, the two gazes inſtantly combine and form a ſolid body, which is nitrate of ammoniac. But, to obtain this ſalt in greater quantity, pure ammoniac is ſaturated with nitric acid, after which the lixivium is evaporated and cryſtallized.

§ CXCVI. Nitrate of ammoniac appears in beautiful acicular cryſtals, which are ſomewhat flexible, and have a cooling but very acrid taſte. It is readily diſſolved in alcohol and cold water, but ſtill more ſo in hot water, of which it requires but half its weight. If the water be cool, a ſenſible degree of cold will be produced. It readily diſſolves ice, and, on this occaſion, the temperature of the ſurrounding bodies is conſiderably diminiſhed.

§ CXCVII. This ſalt, on expoſure to fire, firſt fuſes, and loſes its water of cryſtallization; afterwards it detonates without the addition of any inflammable body. The reſult of this detonation is water and nitrogen gaz, for both the acid and ammoniac are decompoſed, the oxygen of the former, combining with the hydrogen of the latter, forms water, whilſt the nitrogen of both bodies is diſſipated in the ſtate of gaz.

XI. OF MURIATE OF SODA.

§ CXCVIII. Muriate of ſoda, muriated ſoda, common or culinary ſalt, is a neutral ſalt which conſiſts of a peculiar acid and ſoda or the fixed mineral alkali. It has received various denominations, according to the ſtate in which it is found in nature; thus we have Salgem, or rock ſalt, which is digged out of the earth in ſolid maſſes; Bay ſalt, formed by the evaporation of ſea-water, and River-ſalt, obtained from ſalt ſprings.

§ CXCIX. But none of theſe ſalts is pure, they are always mixed with ſome heterogeneous parts; thus rock-ſalt contains gypſum, bay ſalt a great deal of muriate of magneſia, and river-ſalt frequently both. Sometimes they contain by accident bitter ſalt, alum, ammoniacal ſalt, &c. That which is uſed at Vienna is originally rock-ſalt, which has been changed into river-ſalt by art. It contains gypſum and ſulphate of ſoda, but no magneſia.

§ CC. The ſalt compoſed of magneſia and the muriatic acid does not cryſtallize; therefore, during the evaporation of river and ſea water, it remains in the laſt mother-water, which is now no longer fit for boiling. We generally make uſe of ammoniac to precipitate the magneſia, which is thus obtained pure, and fit for medical purpoſes; and the ammoniac is diſengaged by the ſubſequent evaporation of the lixivium.

§ CCI. Common ſalt is purified in the following manner for chemical purpoſes: diſſolve it in diſtilled water, filtrate the lixivium, and add an aqueous ſolution of pure ſoda, till precipitation ceaſes. The lie, being filtrated a ſecond time, muſt be evaporated to a certain degree, and cooled. Should cryſtals of ſulphate of ſoda be depoſited, the lixivium ought to be poured off, and cryſtallized by ſlow evaporation.

The muriate of magneſia, as well as the gypſum, are decompounded by the ſoda. The magneſia and the lime fall to the bottom of the veſſel, and common ſalt and ſulphate of ſoda are formed. The latter, on cooling the lixivium, ſhoots into cryſtals; but the common ſalt, which is equally ſoluble in hot and cold water, is only cryſtallized by protracted evaporation.

§ CCII. The cryſtals of common ſalt are regular cubes, which collectively form an aggregation of ſteps not unlike a ladder, and repreſent hollow quadrangular pyramids. Its peculiar taſte is well known. It may be readily diſſolved in three parts and a half of either hot or cold water, but the ſolution is more rapid in the former. It becomes dry in the atmoſphere, but undergoes no change in conſequence.

§ CCIII. If common ſalt be ſuddenly expoſed to a great heat, it breaks with a crackling noiſe, which phenomenon is termed decrepitation; afterwards it becomes white, and fuſes, but ſuffers no further change. If the heat be intenſe, it becomes perfectly volatile.

§ CCIV. The ſulphuric acid, on account of its greater affinity for ſoda, decompounds common ſalt. Hence, if one part of concentrated ſulphuric acid be added to two parts of common ſalt, previouſly dried, the ſulphuric acid will combine with the ſoda, and produce a new neutral ſalt, viz. ſulphate of ſoda, whilſt the muriatic acid, thus diſengaged, eſcapes in the ſtate of gaz. If this operation be made in the hydrargyropneumatic apparatus, we ſhall obtain muriatic acid gaz, which, being quickly abſorbed by the water, conſtitutes liquid muriatic acid.

§ CCV. To acquire this liquid muriatic acid in greater abundance, you affuſe one part of concentrated ſulphuric acid upon two parts of decrepitated ſalt, in a glaſs retort, on the ſand bath, and apply Woulfe's apparatus, containing one-fourth part water. On the application of a gentle heat, muriatic acid gaz comes over, and is entirely abſorbed by the water, cauſing a conſiderable increaſe of temperature, and after the operation is finiſhed, we have very concentrated and pure muriatic acid in the receivers, and ſulphate of ſoda in the retort.

§ CCVI. Common ſalt is alſo decompounded by ſulphate of iron; but, as the muriatic acid, which is diſengaged, diſſolves the oxide of iron, it is always mixed with ſome particles of the latter, and this method is, therefore, ſeldom uſed.

§ CCVII. Common ſalt is not decompounded by ſilex, and by clay only in a ſlight degree. The latter is, however, readily fuſed when mixed with common ſalt, which is therefore made uſe of for the ſuperficial glazing of earthen ware. For the ſame reaſon common ſalt is added to glaſs that it may fuſe the better.

§ CCVIII. The nitric acid has a greater affinity for ſoda than the muriatic acid, whence it decompoſes common ſalt; but, on account of its volatility, it paſſes into the receiver with the muriatic acid, which, beſides, undergoes another remarkable change during this operation. (§ CCXXIV.)

§ CCIX. The muriatic acid, obtained in this manner, is perfectly colourleſs. It emits white vapours, which, when abſorbed by water, conſtitute the former muriatic acid. It has a peculiar ſuffocating ſmell. Its ſpecific gravity is leſs than that of nitric acid.

§ CCX. One hundred parts of muriatic acid, deprived of water, are ſaturated with 156 parts of ſoda, and thus common ſalt is recompoſed. One hundred parts of this dried and cryſtallized ſalt conſiſt of 33 parts acid, 50 parts ſoda, and 17 parts of water of cryſtallization.

§ CCXI. Notwithſtanding the great improvements in modern chemiſtry, we are as yet perfectly unacquainted with the conſtituent parts of the muriatic acid, and we merely conclude from analogy, that the muriatic, like other acids, is compoſed of oxygen, and a peculiar baſis, at preſent unknown.

§ CCXII. Although the muriatic acid, obtained by the proceſſes before mentioned, be always perfectly ſaturated with oxygen, yet it can take up a ſtill further portion of it, and thus acquire very ſingular properties. This is effected by bringing ſuch bodies into contact with it as contain a large portion of oxygen, but whoſe affinity with oxygen is leſs than that of the muriatic acid. Such bodies are certain metallic oxides.

§ CCXIII. For this purpoſe, take one part of the native oxide of mangane{ſe}, commonly termed manganeſe of glaſs-houſes, red precipitate of mercury, or red lead, put it into a glaſs retort, and add four parts of concentrated muriatic acid. This being diſtilled, you obtain a very conſiderable quantity of a yellow æriform fluid, which is oxygenated muriatic acid gaz; and, by agitating it with water, it combines and forms oxygenated muriatic acid. In this caſe, one part of the muriatic acid unites with the manganeſe, and becomes muriate of manganeſe, whoſe oxygen, being partly diſengaged, combines with the other part of the muriatic acid, which is thus oxygenated.

§ CCXIV. Oxygenated muriatic acid gaz has a yellow tranſparent colour, and poſſeſſes a peculiar and ſuffocating ſmell. It extinguiſhes bodies inflamed, and, of all the gazes with which we are acquainted, it is the moſt noxious to the lungs.

§ CCXV. All vegetable, and moſt animal, bodies, on being immerſed in it, inſtantly loſe their colour, and are bleached. In this caſe the gaz is deprived of its oxygen, and becomes common muriatic acid gaz.

§ CCXVI. Phoſphorous and carbon are immediately inflamed in it, and changed into phoſphoric and carbonic acids. Antimony, biſmuth, and ſeveral other metals, are oxidified in it in an inſtant, when the temperature frequently approaches to candeſcence.

§ CCXVII. To obtain the oxygenated muriatic acid in a liquid ſtate, its gaz is paſſed through water by means of Woulfe's apparatus, the receivers of which are cooled by ice. As ſoon as the water is in a great meaſure ſaturated with the gaz, cryſtals of the oxygenated muriatic acid are formed; but, on the application of a gentle heat, theſe cryſtals melt, and again become oxygenated muriatic acid.

§ CCXVIII. This oxygenated acid is of a yellow colour; it has a peculiar bitter taſte, and emits conſtantly a cloud of ſuffocating vapours. On being expoſed to light, it parts with its oxygen gaz, and common muriatic gaz remains. As this diſengagement of oxygen gaz is in a direct ratio of the quantity of light, the celebrated Sauſſure has employed the oxy-muriatic acid as a photometer.

§ CCXIX. All vegetable bodies, when immerſed in the oxygenated muriatic acid, are inſtantly deprived of their colour, and become white; and therefore this acid has been ſucceſsfully employed for the bleaching of linen, cotton, and wax.

§ CCXX. If the oxygenated muriatic acid gaz be cauſed to paſs through a ſolution of cauſtic pot-aſh, we obtain, beſides common muriate of pot-aſh, a neutral ſalt, which conſiſts of the oxygenated muriatic acid and pot-aſh, termed oxygenated muriate of pot-aſh.

§ CCXXI. This neutral ſalt has bright, hexaëdral, or rhomboidal cryſtals, which are formed during the cooling of the lixivium, and may therefore be ſeparated from the common muriate of pot-aſh. Its taſte is cooling, and by friction in the dark it is phoſphoreſcent. On the contact of inflammable bodies it detonates more violently than nitre; and, on being heated to candeſcence, it affords very pure oxygen gaz, common muriate of pot-aſh remaining behind.

§ CCXXII. The oxygenated muriatic acid combines in the ſame manner with ſoda, but the neutral ſalt, thus formed, does not readily ſhoot into cryſtals. It becomes moiſt in the atmoſphere, and diſſolves in ſpirit of wine.

§ CCXXIII. Oxygenated muriatic acid, when mixed with ammoniac, produces a great efferveſcence. In this caſe, however, no neutral ſalt is formed, but the ammoniac is decompounded, its hydrogen combines with the ſuperabundant oxygen of the acid, and forms water; the nitrogen paſſes off in the ſtate of gaz, and common muriatic acid is left behind. If theſe two bodies be mixed in the ſtate of gaz, the operation is attended with detonation and inflammation.

§ CCXXIV. If two parts of pure nitric acid be mixed with one part of common muriatic acid, the mixture will become hot, aſſume a yellow colour, and emit vapours, the ſmell of which reſembles that of oxygenated muriatic acid. This liquor, on account of its property of diſſolving gold, has received the name of aqua regia. It differs in its properties from both the acids employed.

§ CCXXV. During the preceding operation, a portion of the nitric acid is decompounded; its oxygen combines with the muriatic acid, and forms oxygenated muriatic acid; and the nitrous gaz partly eſcapes, and partly remains in ſolution. As the proportion of each acid cannot be accurately determined, ſome part of the nitric acid generally remains undecompounded. Aqua regia, therefore, conſiſts of oxygenated muriatic acid and of nitrous acid.

§ CCXXVI. The ſpecific gravity of the oxy-muriatic acid, or aqua regia, is leſs than that of the acids employed; its colour is yellow; it emits oxygen gaz when expoſed to light, and, on the application of a gentle heat, oxygenated muriatic acid gaz.

§ CCXXVII. Aqua regia is likewiſe obtained by adding one part of ſal ammoniac, or one part of common ſalt, to four parts of nitric acid; the two neutral ſalts are thus decompounded by the nitric acid, which enters into a ſtate of union with their alkaline baſes, and forms either nitrate of ammoniac, or nitrate of ſoda. The muriatic acid diſengaged then decompounds the remainder of the nitric acid, and forms aqua regia, which, in this caſe, is always mixed, in ſome degree, with either of the neutral ſalts above-mentioned.

XII. OF MURIATE OF POTASH.

§ CCXXVIII. Muriate of pot-aſh, muriated pot-aſh, digeſtive, or febrifuge ſalt of Sylvius, is a neutral ſalt, compoſed of the muriatic acid and pot-aſh. It is found in its native ſtate in ſea-water; in the mother-earth of nitre-manufactories; in various ſalt-ſprings, and in moſt animal humours, though in ſmall quantities. It is produced artificially either by a direct combination, or by the decompoſition of common ſalt and ſal ammoniac by pot-aſh.

§ CCXXIX. This ſalt has rhomboidal, or octaëdral cryſtals. It decrepitates when expoſed to fire; but undergoes no alteration in the air: in other reſpects it reſembles common ſalt, except that its taſte is more penetrating. It requires two parts of cold water for ſolution, and rather a ſmaller quantity if hot.

§ CCXXX. One hundred parts of muriatic acid, deprived of water, are completely ſaturated by 215 parts of pot-aſh; and 100 parts of this cryſtallized ſalt contain 30 parts acid, 63 parts pot-aſh, and 7 parts of water of cryſtallization.

XIII. OF MURIATE OF AMMONIAC.

§ CCXXXI. Muriate of ammoniac, muriated ammoniac, ſal ammoniac, is a neutral ſalt, compoſed of the muriatic acid and ammoniac, or the volatile alkali. It is found ready formed near the craters of volcanos, and in Tartary. It is produced artificially either by a direct or indirect combination of its conſtituent parts. In Egypt it is prepared in great abundance by ſubliming the ſoot obtained from the combuſtion of animal excrements.

§ CCXXXII. The ſal ammoniac of the ſhops, eſpecially that which is brought to us from Egypt, ought to be purified again before it is employed for chemical purpoſes. This is effected in two ways; by ſolution in water, filtration, and cryſtallization, or by ſublimation. It affords, by the firſt method, flexible hexaëdral acicular cryſtals; but, by the ſecond, a ſaline maſs, more or leſs ſolid and ſemitranſparent, in which we ſometimes meet with cryſtals of a cubic form, called flowers of ſal ammoniac.

§ CCXXXIII. The taſte of ſal ammoniac is ſimilar to that of common ſalt, but ſomewhat more acid. Its chryſtals remain unchanged in the atmoſphere. They are ſublimed in a ſtrong fire without decompoſition. Six parts of cold water diſſolve them, and this operation is attended by a conſiderable diminution of temperature. They require no more than their own weight of boiling water, and the ſolution, on being cooled, again depoſits cryſtals.

§ CCXXXIV. Sal ammoniac is likewiſe decompoſed by the ſulphuric and nitric acids, which enter into combination with its alkaline baſis. Each of theſe acids has, therefore, the power of ſeparating the muriatic acid from ſal ammoniac. The former produces ſulphate, and the latter nitrate of ammoniac.

§ CCXXXV. Sal ammoniac is not at all decompounded by alumine, and but very imperfectly by magneſia. Pure calcareous and ponderous earths, decompoſe it, however, in the moſt perfect manner; they combine with the muriatic acid, and ſeparate the ammoniac. Hence, if dry ſal ammoniac be triturated with quick-lime, the ammoniac is diſengaged in the ſtate of gaz, and the reſidue is muriate of lime. If this proceſs be inſtituted in the hydrargyropneumatic apparatus we ſhall obtain a tranſparent colourleſs gaz, viz. ammoniacal gaz, which is readily abſorbed by the water, thus forming a ſolution of pure or cauſtic ammoniac.

§ CCXXXVI. To obtain this pure ammoniac in a liquid ſtate, one part of dry ſal ammoniac is mixed with three parts of quick-lime, and introduced into a glaſs retort fitted to Woulfe's apparatus with one-half part of water. The diſtillation is then commenced by a gentle fire, which is gradually increaſed till the retort becomes red-hot. The pure ammoniac, which comes over in the ſtate of gaz, is abſorbed by the water of the receivers, with a conſiderable increaſe of temperature, and, after the operation is finiſhed, we ſhall have pure ammoniac in a liquid ſtate. The reſidue in the retort is muriate of lime or fixed ſal ammoniac, which is ſeparated from the ſuperfluous lime by ſolution in water and filtration.

§ CCXXXVII. Sal ammoniac is decompounded in the ſame manner by the other fixed, pure, or cauſtic alkalis; and pure ammoniac is, therefore, equally prepared with cauſtic pot aſh and cauſtic ſoda. In the former caſe, the reſidue is muriate of pot aſh, in the latter common ſalt.

§ CCXXXVIII. But, if aërated alkalis be employed in this operation inſtead of cauſtic alkalis, a double decompoſition will take place; the muriatic acid unites with the alkalis, and the ammoniac, being diſengaged, combines with the carbonic acid of thoſe alkalis, and forms carbonate of ammoniac, or aërated volatile alkaline ſalt.

§ CCXXXIX. To obtain this mild ammoniac take equal parts of pure ſal ammoniac and of mild pot-aſh or ſoda, previouſly dried; put them into a glaſs retort, and attach a common large receiver,—

The retort being then expoſed to fire, which is gradually increaſed, mild ammoniac comes over in the ſtate of gaz, and adheres to the ſides of the receiver in the form of beautiful white cryſtals, which, when diſſolved in water, form liquid carbonate of ammoniac. Upon the ſame principle, carbonate of ammoniac is prepared by ſubliming one part of ſal ammoniac with two parts of chalk, or mild calcareous earth.

§ CCXL. One hundred parts of pure muriatic acid require 79 parts of ammoniac for perfect ſaturation; and 100 parts of cryſtallized muriate of ammoniac conſiſt of 52 parts acid, 40 parts pure ammoniac, and 8 parts water of cryſtallization.

XIV. OF SULPHATE OF POTASH.

§ CCXLI. Sulphate of pot-aſh, vitriolated pot-aſh, arcanum duplicatum, vitriolated tartar, is a neutral ſalt, compoſed of the ſulphuric acid and pot-aſh. It is ſcarcely ever found native, and we generally obtain it by the direct or indirect combination of its conſtituent parts.

§ CCXLII. It has a bitter and ungrateful taſte. Its cryſtals have the form of hexaëdral pyramids, which are not changed in the atmoſphere. On expoſure to fire it decrepitates and becomes white; and, if the heat be intenſe, it melts and volatilizes without decompoſition.

§ CCXLIII. This ſalt is not acted upon by any earth, baryt excepted, which decompoſes it; for the ſulphuric acid combines with it, and forms ſulphate of baryt, and the pot-aſh is diſengaged.

§ CCXLIV. Sulphate of pot-aſh is perfectly diſſolved in 18 parts of cold water; but it requires no more than about 5 parts of boiling water. Hence the ſolution is eaſily cryſtallized by cooling.

§ CCXLV. One hundred parts of ſulphuric acid, free from water, require 215 parts of pot-aſh for complete ſaturation; and 100 parts of the cryſtals of ſulphate of pot-aſh contain 66.67 parts of pot-aſh, 25.51 parts of acid, and 4.82 of water of cryſtallization.

§ CCXLVI. This neutral ſalt may be ſuperſaturated with its acids. If pure ſulphuric acid be diſtilled in a retort upon ſulphate of pot-aſh, acidulous ſulphate of pot-aſh will be obtained. This ſalt effloreſces in the atmoſphere, and is in part decompounded by the nitric and muriatic acids.

§ CCXLVII. From the combination of the ſulphureous acid and pot-aſh ariſes a neutral ſalt, known by the name of Stahl's ſalt of ſulphur, or ſulphite of pot-aſh, which differs from common ſulphate of pot-aſh in this, that its taſte is extremely bitter, that it deliqueſces in the atmoſphere, is readily diſſolved in water, and decompounded by almoſt all the mineral, and ſome of the vegetable acids. When expoſed to the air, it gradually abſorbs oxygen, and becomes common ſulphate of pot aſh.

XV. OF SULPHATE OF SODA.

§ CCXLVIII. Sulphate of ſoda, vitriolated ſoda, Glauber's ſal-mirabilis, is a neutral ſalt, which conſiſts of the ſulphuric acid and ſoda. It is found native in various ſaline ſprings and mineral waters; on the walls of houſes, in mines, &c. In the ſouth of France it is obtained by boiling the tamarix gallica, a plant which grows near the ſea. It is formed artificially by the direct or indirect combination of its conſtituent parts.

§ CCXLIX. The taſte of this ſalt is at firſt cooling, but afterwards extremely bitter. Its cryſtals are ſix-ſided priſms, with diaëdral extremities, which, when in contact with the atmoſphere, loſe their water of cryſtallization, and become pulverulent. On expoſure to the fire, they liquify in a ſhort time; but, after their water of cryſtallization is expelled, they require an intenſe heat for fuſion, by which they undergo no decompoſition, but, at laſt, become volatile.

§ CCL. Sulphate of ſoda is perfectly ſoluble in its own weight of boiling water and in four parts of cold water, and the ſolution, when cooled, readily ſhoots into beautiful cryſtals.

§ CCLI. This ſalt is decompounded by cauſtic pot-aſh and ponderous earth; the former produces ſulphate of pot-aſh, and the latter, ſulphate of baryt; in both caſes the ſoda is precipitated.

§ CCLII. One hundred parts of ſulphuric acid require 165 parts of ſoda for complete ſaturation; and 100 parts of Glauber's ſalt contain 21.87 parts of ſoda, 13.19 parts of ſulphuric acid, and 64.94 parts of water of cryſtallization.

§ CCLIII. Sulphate of ſoda, like ſulphate of potaſh, can be ſuperſaturated by its own acid, and form acidulous ſulphate of ſoda, which is alſo decompounded by the nitric and muriatic acids.

XVI. OF SULPHATE OF AMMONIAC.

§ CCLIV. Sulphate of ammoniac, or Glauber's ſecret ammoniacal ſalt, is a neutral ſalt, formed by the ſulphuric acid and ammoniac. It is ſaid to be found ready formed, with the muriate of ammoniac, near volcanos, and in ſome of the lakes of Tuſcany. It is produced artificially by the direct or indirect combination of its component parts.

§ CCLV. Sulphate of ammoniac has a very bitter taſte. Its cryſtals are thin flat hexaëdral priſms, with pyramidal extremities. They neither deliqueſce nor effloreſce in the air. Expoſed to fire, they ſoon become fluid, on account of their water, which being diſſipated, they become dry, red hot, fuſe, and are partly volatilized.

§ CCLVI. This ſalt readily diſſolves in two parts of cold water, and during the ſolution a conſiderable diminution of temperature takes place; boiling water diſſolves its own weight; the ſolution cryſtallizes when cooled: the fineſt cryſtals, however, are obtained by ſlow evaporation in the atmoſphere.

§ CCLVII. Pure calcareous and ponderous earth, and the mild and cauſtic alkalis, decompoſe this ſalt, and diſengage the ammoniac; and the reſidue is either ſulphate of lime, ſulphate of baryt, ſulphate of ſoda, or ſulphate of pot-aſh; if mild alkalis be employed, carbonate of ammoniac will be precipitated.

§ CCLVIII. This ſalt, like the ſulphates of ſoda and of pot-aſh, is partly decompounded by the nitric and muriatic acids.

XVII. OF BORAX.

§ CCLIX. Borax is a neutral ſalt, conſiſting of the boracic acid, or ſedative ſalt, ſuperſaturated with ſoda. Native borax, mixed with different earthy particles, is imported from the Eaſt-Indies and China by the name of tincal. It is ſaid, that in the Eaſt-Indies they obtain it from various mineral waters, which are collected in artificial trenches, and afterwards evaporated by the heat of the ſun. The origin of the Chineſe tincal is ſtill more obſcure. It has been alſo found, in conſiderable abundance, in the mines of Riquintipa, near Eſcapa. Finally, the boracic acid, or ſedative ſalt, has been detected in the lakes of Cherchiajo, and Caſtelnuovo in Tuſcany.

§ CCLX. Tincal is a ſalt of a greeniſh colour, the cryſtals of which are flat hexaëdral priſms. In Europe, and particularly in Holland, it is purified from the extraneous matter with which it is mixed, and afterwards ſuperſaturated with ſoda, and ſold by the name of borax. Tincal, therefore, differs from borax merely in being mixed with foreign particles, which are ſeparated by repeated ſolutions in water, and by cryſtallization, and in not being ſuperſaturated with ſoda.

§ CCLXI. Borax has a ſubaſtringent and ſomewhat alkaline taſte, its cryſtals are compreſſed hexaëdral priſms, with diaëdral extremities. They loſe their ſplendor when expoſed to the atmoſphere, becauſe their ſurface is deprived of the water of cryſtallization.

§ CCLXII. This ſalt liquifies with great facility on expoſure to fire, which cauſes it to ſwell into a light and porous maſs, termed calcined borax; if the heat be increaſed, it fuſes, and becomes a white tranſparent glaſs, which only differs from the former borax in being deprived of its water of cryſtallization.

§ CCLXIII. Borax is readily diſſolved in twelve parts of cold, and in ſix parts of boiling, water; the ſolution readily cryſtallizes on cooling.

§ CCLXIV. The ſulphuric acid decompounds borax, and diſengages its acid. To this end concentrated ſulphuric acid is added to a hot ſolution of borax, till the lixivium becomes ſomewhat acid; the ſolution being then cooled, boracic acid, in the ſhape of bright ſcales, begins to be formed; the remaining part of the lixivium, being repeatedly evaporated, yields at firſt boracic acid, but afterwards ſulphate of ſoda.

§ CCLXV. In the ſame manner the acid of borax may be ſeparated from borax, by the nitric, muriatic, and even vegetable acid; and we obtain, by evaporating the lixivium, various neutral ſalts, according to the acid employed.

§ CCLXVI. Sedative ſalt, or the acid of borax, has a weak acid taſte, and produces no particular change on the blue juices of vegetables. Its cryſtals are irregular brilliant ſcales, and of great levity. It diſſolves in 20 parts of cold water, and in 3 parts of hot; it is readily diſſolved likewiſe in ſpirit of wine, which then burns with a green flame.

§ CCLXVII. This ſalt, if dry, ſuffers no alteration by fire, but is at laſt fuſed into a tranſparent glaſs. If moiſtened with water, and expoſed to fire in a cucurbit, it is ſublimed, and becomes very white.

§ CCLXVIII. Borax, as well as the boracic acid, accelerates the fuſion of earths and ſtones; the former, therefore, is highly uſeful both in chemiſtry and the arts; but, as its intumeſcence on the application of heat is great, and may prove inconvenient, if not injurious, we generally employ calcined borax, or, which is ſtill preferable, the glaſs of borax.

§ CCLXIX. According to Bergmann, 100 parts of borax contain 34 parts of acid, 17 parts of ſoda, and 49 parts of water of cryſtallization.

XVIII. OF BORATE OF POT-ASH.

§ CCLXX. Borate of pot-aſh is a neutral ſalt, formed of the boracic acid and pot-aſh. It is prepared either by the direct ſaturation of boracic acid with pot-aſh or the fixed vegetable alkali, or indirectly, during the decompoſition of nitre, in the dry way, by the boracic acid.

§ CCLXXI. The properties of this neutral ſalt are as yet but imperfectly known; if ſlowly evaporated, it ſhoots into priſmatic tetraëdral cryſtals, which ſuffer no change from the atmoſphere, and, expoſed to a ſtronger fire, fuſe, like borax, into a glaſs, which is ſoluble in water.

XIX. OF BORATE OF AMMONIAC.

§ CCLXXII. Borate of ammoniac is a neutral ſalt, which conſiſts of boracic acid and ammoniac. It is obtained by direct combination, when boracic acid is digeſted upon cauſtic ammoniac to the point of ſaturation, and the ſolution evaporated, cooled, and cryſtallized.

§ CCLXXIII. This ſalt has a penetrating taſte; its cryſtals are polyaëdral, which effloreſce on expoſure to the atmoſphere. It is decompounded by heat, for the ammoniac is developed, and the reſiduum is ſedative ſalt. Ammoniac is likewiſe ſeparated from the boracic acid by quick-lime.

XX. OF THE FLUORIC ACID.

§ CCLXXIV. Mineralogiſts have been long acquainted with a peculiar ſpecies of ſtone, which, from its property of accelerating the fuſion of other ſtones, was diſtinguiſhed by the name of fluor; but it is only within theſe few years that its conſtituent parts have been accurately determined. The celebrated Scheele was the firſt who demonſtrated that this ſtone conſiſts chiefly of an earthy ſalt, compoſed of lime and a peculiar acid, which, from its origin, he termed acid of fluor, or fluoric acid.

§ CCLXXV. If equal parts of fluor and of concentrated ſulphuric acid be put into a leaden retort, and diſtilled by a gentle heat, a gaz, termed fluoric acid gaz, is obtained in the hydrargyropneumatic apparatus, previouſly applied. The fluor is thus decompounded; the ſulphuric acid combines with the calcareous earth, and forms gypſum, and the fluoric acid is diſengaged.

§ CCLXXVI. Fluoric acid gaz is readily abſorbed by water, in which caſe it forms liquid fluoric acid. To obtain it in greater abundance, the above mixture ſhould be diſtilled in a leaden retort, with Woulfe's apparatus conſtructed of lead.

§ CCLXXVII. Concentrated fluoric acid poſſeſſes a peculiar taſte and ſmell, and conſtantly emits white and ſuffocating vapours. It has the power, above all other acids, of diſſolving pure ſiliceous earth and glaſs.

§ CCLXXVIII. On account of this latter property of the fluoric acid, it has been ſucceſsfully employed for etching on glaſs. The fluoric acid uſed for this purpoſe is either liquid, or, which is preferable, in the ſtate of gaz.

XXI. OF ALKALINE FLUATES.

§ CCLXXIX. The neutral ſalts termed fluates have been hitherto but ſlightly examined; they are all formed by direct combination; but it is neceſſary that the fluoric acid employed ſhould be perfectly free from ſiliceous earth, otherwiſe ſuch earth is ſeparated during the combination of the acid with the alkalis, and a gelatinous uncryſtallizable maſs is formed.

§ CCLXXX. Pure fluoric acid, ſaturated with pot-aſh, forms fluate of pot-aſh, a ſalt which readily diſſolves in water, deliqueſces in the atmoſphere, and is not cryſtallized but with great difficulty. It is decompounded by the ſulphuric acid and quick-lime; in the former caſe, the ſulphuric acid combines with the pot-aſh, and forms ſulphate of pot-aſh, and fluoric acid is diſengaged, (§ CCLXXV.); in the latter, the quicklime combines with the fluoric acid, and forms regenerated fluor, which is precipitated, it being ſcarcely ſoluble.

§ CCLXXXI. Fluate of ſoda differs from the former ſalt, as it is with great difficulty ſoluble in water, and ſhoots into ſmall oblong tetraëdral cryſtals of a bitter taſte, and which, like common ſalt, decrepitate on expoſure to a red heat. This neutral ſalt, like the preceding one, is decompounded by the ſulphuric acid and quick-lime.

§ CCLXXXII. The combination of the fluoric acid and ammoniac produces a neutral ſalt, viz. fluate of ammoniac, the lixivium of which, when evaporated, forms ſmall columnar cryſtals, which are deliqueſcent in the atmoſphere, have a bitter taſte, are perfectly ſublimed by heat, and, according to Wiegleb, act in the ſame manner upon glaſs and ſiliceous earth as the fluoric acid.

XXII. OF THE CARBONIC ACID.

§ CCLXXXIII. Chemiſts, at an early period, had noticed the two-fold ſtate in which alkalis and calcareous earths are found, and accordingly had termed them cauſtic or mild; but it is only known ſince the experiments of Dr. Black, that the different ſtates in which thoſe bodies appear depend upon the preſence or abſence of the baſis of that gaz, which he denominated fixed air. Modern Chemiſts have made farther diſcoveries upon this ſubject, and have proved that fixed air is a true acid of a peculiar kind, which, becauſe it was found in the atmoſphere, received the name of ærial acid; but, ſince its conſtituent parts are better known, it is termed carbonic acid.

CCLXXXIV. This acid occurs not only in thoſe compound ſtates we have mentioned, but likewiſe in various other ways, ready formed. Thus we find it in many mineral waters, which, from the peculiar taſte communicated to them by this acid, are termed acidulous mineral waters; alſo in a gazeous and very pure ſtate, in a great number of ſubterraneous cavities; in the atmoſphere, of which it occupies 1-100th part; and it is frequently generated and diſengaged during the change and decompoſition of vegetable and animal matter. Finally, we obtain it artificially by the decompoſition of neutral carbonic acid ſalts, by means of other acids, or, which anſwers the ſame end, by diſſolving mild pot-aſh and common lime-ſtone in acids; or by decompoſing theſe bodies by fire.

§ CCLXXXV. Hence, if any acid be poured upon common calcareous earth, in the pneumatic apparatus, ſuch earth will be decompounded; the acid affuſed combines with the lime, and forms a new neutral ſalt; and the carbonic acid is diſengaged, and eſcapes in the ſtate of a colourleſs gaz, viz. carbonic acid gaz.

§ CCLXXXVI. This gaz changes the blue juices of vegetables red. Its ſpecific gravity to that of the atmoſphere is about 1 $\frac{1}{2}$ to 1. A cubic inch weighs 0.68985 of a grain. Animals die in it in a very ſhort ſpace of time, and flame is inſtantly extinguiſhed.

§ CCLXXXVII. This gaz may be readily combined with an equal part of cold water; and different machines have been invented for the purpoſe of impregnating water in an eaſy and cheap way with carbonic acid, in imitation of mineral waters.

§ CCLXXXVIII. Carbonic acid gaz diſſolved in water, or liquid carbonic acid, has a peculiar and pungent taſte; it changes the blue juices of vegetables red, and is again deprived of its water, either by heat or congelation.

§ CCLXXXIX. It is demonſtrated by the experiments of modern chemiſts, that carbonic acid, like all other acids, conſiſts of oxygen, and a baſis which is carbon or pure charcoal; for, whenever pure charcoal is burned, that is, combined with oxygen, carbonic acid is produced, and in a proportion preciſely equal to the weight of the carbon and oxygen employed. This acid is formed likewiſe by heating the calces of metals, or metallic oxides, in fire, with carbon; and by direct combination during the reſpiration of animals.

XXIII. OF CARBONATE OF POTASH.

§ CCXC. Carbonate of pot-aſh, ærated pot-aſh, mild or common pot-aſh, common or ærated fixed vegetable alkali, is a perfect neutral ſalt, which conſiſts of pure or cauſtic pot-aſh and carbonic acid.— It is obtained by indirect combination in various proceſſes, and by direct combination, when a ſaturated ſolution of pure pot-aſh is impregnated with carbonic acid to ſaturation.

§ CCXCI. This neutral ſalt forms regular cryſtals, which repreſent tetraëdral priſms, terminating in ſhort tetraëdral points. It has an urinous taſte, and changes the ſyrup of violets green. On expoſure to the atmoſphere it does not deliqueſce, but rather effloreſces; in the fire it readily melts, and is decompounded, its water of cryſtallization and acid are for the moſt part expelled, and pure pot-aſh remains. Four parts of cold water are required for its ſolution, and rather a ſmaller quantity of hot water.

§ CCXCII. All acids decompoſe mild pot-aſh in the moiſt way; hence new neutral ſalts are produced, which differ according to the acid employed, and the carbonic acid eſcapes in the ſtate of gaz.—This ſalt is equally decompounded, in the dry way, by ſiliceous earth, which combines with the pure pot-aſh, and forms glaſs, whilſt the carbonic acid is expelled. This accounts for the effervescence which takes place during the fuſion of the mixture.

§ CCXCIII. This ſalt is likewiſe decompounded by quicklime; the carbonic acid unites with the lime, which becomes ærated, and quits the pot-aſh, which is thus rendered pure or cauſtic. Hence, if three parts of quicklime be mixed with one part of mild pot-aſh, diſſolved in water, and the ſolution be filtrated and evaporated to dryneſs, we ſhall obtain pure or cauſtic pot-aſh, which in pharmacy is known by the name of lapis cauſticus.

§ CCXCIV. The taſte of pure pot-aſh is ſo very acrid that it erodes the tongue. It combines with acids, without efferveſcence. It inſtantly changes the blue juices of vegetables to a dark green, but this colour is ultimately deſtroyed, and becomes brown, inclining to yellow. Expoſed to the fire, it fuſes, after becoming red hot, without decompoſition; and an intenſe heat is requiſite to render it volatile.

§ CCXCV. It quickly deliqueſces on expoſure to the atmoſphere, from which it attracts the carbonic acid; and being then combined with acids, it again effervefces. It readily diſſolves in water, with increaſe of temperature. To render it ſolid again, it ought to be evaporated to dryneſs, but on this occaſion it never aſſumes a cryſtallized form.

§ CCXCVI. Siliceous and ſeveral other earths are diſſolved by it in the dry way, and in conſequence become vitreous maſſes, more or leſs tranſparent.

XXIV. OF CARBONATE OF SODA.

§ CCXCVII. Carbonate of ſoda, mild or ærated ſoda, ærated fixed mineral alkali, is a perfect neutral ſalt, conſiſting of the carbonic acid and pure or cauſtic ſoda. In Hungary, Egypt, Perſia, the Eaſt Indies, and China, it is found ready formed on the ſurface of the earth; likewiſe in a great many mineral waters, and on old walls. But, as this native carbonate of ſoda is never completely ſaturated with the carbonic acid, it is neceſſary to have recourſe to art, to obtain it in that ſtate. This ſalt is likewiſe formed by the direct combination of its conſtituent parts; and, indirectly, by the decompoſition of other neutral ſalts; and by the lixiviation of the aſhes of plants growing near the ſea.

§ CCXCVIII. The completely ſaturated carbonate of ſoda has rhomboidal cryſtals, which repreſent an aggregation of ſcales. On expoſure to the atmoſphere, it loſes its water of cryſtallization and effloreſces. Fire acts upon it in the ſame manner as upon carbonate of pot-aſh. Its taſte is urinous, but leſs acrid than that of mild potaſh. It changes the blue juices of vegetables green.

§ CCXCIX. This ſalt requires two parts of cold water for perfect ſaturation, but only an equal quantity of boiling water. Hence, it readily cryſtallizes on the cooling of the lixivium; the chryſtals, however, will be more beautiful if the evaporation be carried on ſlowly.

§ CCC. Acids and vitrifiable earths have the ſame effect upon carbonate of ſoda as upon carbonate of pot-aſh, except that the glaſs, produced in the latter caſe, is more durable, and fuſes with greater facility.

§ CCCI. Carbonate of ſoda is decompounded by quicklime and pure ponderous earth, in the ſame manner as carbonate of pot-aſh; and pure or cauſtic ſoda may be obtained according to the ſame method, and by the ſame proceſs, that we obtain cauſtic pot-aſh; and pure or cauſtic ſoda differs from mild ſoda, for the ſame reaſon that mild pot-aſh differs from cauſtic.

§ CCCII. The compoſition of the fixed cauſtic alkalis, notwithſtanding the numerous experiments made on this ſubject, remains as yet obſcure; and we are ſtill obliged to conſider them as ſimple bodies, although it be very probable that they are compoſed of different elements. Some modern chemiſts ſuſpect that nitrogen conſtitutes one of their general principles.

XXV. OF CARBONATE OF AMMONIAC.

§ CCCIII. Carbonate of ammoniac, or mild volatile alkali, is a perfect neutral ſalt, which conſiſts of the carbonic acid and pure or cauſtic ammoniac. Hitherto it has not been found in nature, and it is always produced either by direct combination, by the double decompoſition of other neutral ſalts, or the decompoſition of animal matter, and of certain other bodies by fire.

§ CCCIV. The cryſtals of this ſalt are tetraëdral columns; they attract but a ſmall portion of moiſture from the atmoſphere, have an urinous taſte, and impart a green colour to ſyrup of violets. They readily liquify in the fire, and are almoſt, at the ſame time, entirely ſublimed. Their ſolution is effected in two parts of cold water, and attended by the production of cold; of boiling water they require a quantity ſomewhat leſs.

§ CCCV. This ſalt, like all others formed by the carbonic acid, is decompounded by quicklime. In this caſe, however, pure ammoniac paſſes off in the ſtate of gaz. It is likewiſe decompoſed by the fixed or cauſtic alkalis, which diſengage the ammoniac.

§ CCCVI. Pure or cauſtic ammoniac is never ſeen in a ſolid, but always in an æriform or liquid ſtate. It differs alſo from mild ammoniac, as fixed or cauſtic alkalis differ from mild alkalis.

§ CCCVII. The celebrated Bertholet has diſcovered, that pure ammoniac conſiſts of nitrogen and hydrogen; and that 1000 parts of pure ammoniac contain 807 parts nitrogen, and 193 parts hydrogen. This will be demonſtrated by the following experiments.

§ CCCVIII. If an uninterrupted ſtream of electric ſparks be paſſed through a determinate quantity of ammoniacal gaz, the volume of this gaz will be almoſt trebled, and at length the whole will be changed into a mechanical mixture of inflammable and nitrogen gazes.

§ CCCIX. Introduce a determinate quantity of pure liquid ammoniac into a glaſs retort, whoſe neck is connected with a porcelain tube, containing common or calcined manganeſe, heated red hot, in an adjoining furnace. Fire being now applied to the retort, the ammoniac is forced to paſs through the red hot manganeſe in the tube, and, conſequently, a certain quantity of water and of nitrous gaz is obtained in the receivers. The ammoniac is thus decompounded; its two principles combine ſeparately with the oxygen of the manganeſe, and form water and nitrous gaz.

§ CCCX. The compoſition of ammoniac can be alſo proved from the ſtate of flaming nitre in fire; from the effects of the oxygenated muriatic acid, or cauſtic ſpirit of ſal ammoniac, (§ CCXXIII.) and from a great number of experiments, which we ſhall have occaſion to mention hereafter.

XXVI. OF EARTHS IN GENERAL.

§ CCCXI. Chemiſts have given the denomination of earth to ſuch bodies as are inodorous, inſipid, pulverulent or friable, uninflammable, ſcarcely ſoluble in water, unchangeable in the fire; whoſe ſpecific gravity is not more than 5, and which, when heated, either by themſelves or with inflammable bodies, do not acquire metallic ſplendour.

§ CCCXII. Thoſe earths, which have not hitherto been decompounded, are termed elementary or ſimple earths. Of this kind, we reckon the following ſeven: 1. Calcareous earth, or Lime; 2. Ponderous earth, or Baryt; 3. Argillaceous earth, or Alumine; 4. Earth of bitter ſalt or Magneſia; 5. Siliceous earth, or Silica; 6. Earth of adamantine ſpar; 7. Jargon earth. Theſe ſimple earths conſtitute the principles of all thoſe, termed compound earths, ſtones, &c.

§ CCCXIII. Simple earths are ſubdivided into ſuch as are capable of combining with acids, and ſorming neutral ſalts, and into ſuch as are inſoluble in acids. The former are termed alkaline or abſorbent earths, and to this claſs belong the four firſt of the earths above-mentioned.

§ CCCXIV. Earths in their natural ſtate are ſeldom pure, for, in general, they are either combined with other earths, or with different bodies. According to their ſtate of aggregation, they aſſume various external properties; to enumerate theſe is the work of mineralogiſts; it is our province only to examine their chemical properties when in a ſtate of purity.

XXVII. OF CALCAREOUS EARTH.

§ CCCXV. Cauſtic, or pure calcareous earth, in a ſtate of mixture with ærated calcareous earth, has been hitherto only found at Bath, and near the craters of ſome ancient volcanos. It is obtained artificially by the decompoſition of common calcareous earth, by fire, or by the decompoſition of other calcareous ſalts by fixed alkalis, when it is termed quicklime.

§ CCCXVI. Quicklime has an acrid, urinous, and corroſive taſte. It changes the colour of violets green, and in the end deſtroys it. Its ſpecific gravity, according to Bergmann, is 2. 720. It undergoes no change in the fire, nor can it be fuſed in the moſt intenſe heat, unleſs in contact with fuſible bodies.

§ CCCXVII. On expoſure to the atmoſphere it becomes hot, intumeſcent, and is at length reduced to powder. The moiſter the atmoſphere is, the ſooner does this phenomenon happen. The lime is then ſaid to be lime ſlaked in air. Calcareous earth, deprived of its water by burning, again attracts it from the atmoſphere, and, at the ſame time, parts with a conſiderable quantity of caloric. By diſtillation in an intenſe heat, however, this water may be expelled a ſecond time, and the former quicklime reſtored. But, if this ſlaked lime be expoſed to the atmoſphere ſome time longer, it becomes ſaturated by degrees with carbonic acid, and is reduced to the ſtate of ærated calcareous earth.

§ CCCXVIII. If a ſmall quantity of water be ſprinkled upon quicklime, it is eagerly abſorbed, and the quicklime remains as dry as before; but it quickly breaks with a crackling noiſe, falls to an impalpable powder, and at the ſame time produces a conſiderable degree of heat. This is attended by a peculiar ſmell, and phoſphoreſcence in the dark. The ſame effects are produced as mentioned in the preceding ſection, but more rapidly. Lime, thus ſaturated with as much water as it can hold in a dry ſtate, is termed ſlaked lime.

§ CCCXIX. A freſh quantity of water, added to ſuch lime, diſſolves it without exciting heat; 680 parts of water, at the temperature of the atmoſphere, take up one part of quick lime; and this ſolution is termed lime-water.

§ CCCXX. Lime-water is a tranſparent colourleſs fluid, the ſpecific gravity of which ſcarcely exceeds that of pure water. It has an acrid taſte, changes at firſt the colour of ſyrup of violets green, and afterwards deſtroys it. Expoſed for ſome time to the atmoſphere, its ſurface is inveſted with an earthy pellicle, termed cream of lime, which, when removed, is replaced by a new one. This ſubſtance is carbonate of lime, a neutral ſalt, inſoluble in water, formed by the combination of the carbonic acid of the atmoſphere and the lime of the lime-water.

§ CCCXXI. This ſeparation of calcareous earth from lime-water proceeds ſtill more rapidly, if the lime-water be brought into contact with carbonic acid gaz, or if this gaz be conducted through it. Calcareous earth in an ærated ſtate is alſo precipitated, if to the lime water be added a ſolution of mild pot-aſh, which thus becomes cauſtic. (§ CCXCIII. & CCCI.)

§ CCCXXII. Pure diſtilled water is carried into the receiver by evaporating lime-water in cloſe veſſels; and quicklime remains behind. It requires, however, an intenſe heat to ſeparate the laſt particles of water from the lime.

§ CCCXXIII. Quicklime diſſolves ſiliceous earth in the moiſt way. Hence, if ſand be added to lime recently ſlaked, the mixture obtains a greater conſiſtence, and at laſt becomes very hard. This compound is termed mortar, the quality of which depends upon the proportion of the lime and ſand; upon the degree to which the lime is ſlaked, previous to its being mixed; and upon the tenuity and uniformity of the ſand. Quicklime combines in the ſame manner with clay burned by art or volcanos, and forms excellent mortar.

§ CCCXXIV. In the dry way, quicklime combines with ſilica, clay, and magneſia, and forms more or leſs tranſparent ſcoriæ or glaſs.

XXVIII. OF SULPHATE OF LIME.

§ CCCXXV. The combination of lime and the ſulphuric acid forms an earthy ſalt, known by the name of vitriolated lime, ſulphate of lime, ſelenite, or gypſum. Immenſe ſtrata of this ſalt are found in almoſt every part of Europe, and it is alſo contained in a great many mineral waters. In the former ſtate, mineralogiſts, on account of its external form, diſtinguiſh it by the terms lapis gypſius, glacies mariæ, gypſum ſtriatum, &c. This ſalt may be alſo formed by a direct or indirect combination of its conſtituent parts.

§ CCCXXVI. Gypſum, or ſelenite, forms flat priſmatic cryſtals, which remain unaltered in the atmoſphere. It requires 500 parts of cold, and 470 parts of boiling water, for perfect ſolution; and hence we can only obtain it in beautiful chryſtals by ſlow evaporation in the open air. One hundred parts of this ſalt contain 32 parts of lime, 30 parts ſulphuric acid, and 38 parts of water of cryſtallization.

§ CCCXXVII. Gypſum, on expoſure to fire, loſes its water of cryſtallization, and is reduced to a white powder, or burned gypſum; and if the heat be intenſe, it melts into a cream-coloured glaſs.

§ CCCXXVIII. Water, poured upon burned gypſum, is greedily abſorbed, whilſt the temperature is conſiderably increaſed, and the gypſum becomes a paſte, which ſoon hardens, termed ſlaked gypſum.

§ CCCXXIX. Gypſum is decompounded by baryt and the fixed alkalis. They combine with the ſulphuric acid, and produce new neutral ſalts, at the ſame time that pure calcareous earth is ſeparated. It is equally decompounded by the mild fixed alkalis and mild ammoniac; in this caſe, however, the calcareous earth diſengaged is mild or ærated.

XXIX. OF NITRATE OF LIME.

§ CCCXXX. Nitrate of lime, nitrated lime, calcareous or earthy nitre, is an earthy ſalt, which conſiſts of the nitric acid and lime. It is found in the mother-earth of nitre manufactories, on old walls, and mixed with true native nitre in the kingdom of Naples. The pureſt is obtained by the artificial and direct combination of its conſtituent parts.

§ CCCXXXI. It is extremely difficult to cryſtallize this ſalt. The cryſtals in that caſe repreſent ſix-ſided priſms, with diaëdral extremities. It has an acrid taſte, and deliqueſces very readily in the open air, by attracting from it a conſiderable quantity of water.

§ CCCXXXII. It is completely ſoluble in half its weight of cold water, and in an equal part of alcohol. Expoſed to fire, it fuſes, and is decompounded; the nitric acid eſcapes as ſuch for the moſt part, and partly paſſes off in the ſtate of oxygen and nitrogen gazes, when pure calcareous earth remains, which now poſſeſſes the property of attracting light, and of being luminous in the dark. It is known, from its inventor, by the name of Baldwin's phoſphorus.

§ CCCXXXIII. One hundred parts of nitric acid are ſaturated with 96 parts of lime, and 100 parts of the cryſtals of nitrate of lime contain 43 parts acid, 22 parts lime, and 35 parts water of cryſtallization.

XXX. OF MURIATE OF LIME.

§ CCCXXXIV. Muriate of lime, or Glauber's fixed ſal ammoniac, is an earthy ſalt which conſiſts of the muriatic acid and lime. It is found native in ſea-water, and in the mother-water of culinary ſalt. It is likewiſe obtained either by direct combination, or by the decompoſition of ſal ammoniac by quicklime. (§ CCXXXVI.)

§ CCCXXXV. The cryſtallization of this ſalt is attended with great difficulty. Its cryſtals are tetraëdral priſms, which poſſeſs an acrid and diſagreeable taſte. On expoſure to the atmoſphere it deliqueſces in a very ſhort time, when, formerly, it was termed oil of lime. In the fire it readily melts, becomes dry, and remains undecompounded. During this proceſs, it obtains the property of ſhining in the dark; and this phenomenon having been firſt obſerved by Homberg, it has been termed Homberg's phoſphorus.

§ CCCXXXVI. One part and a half of cold water readily diſſolve one part of muriate of lime; and boiling water diſſolves more than its own weight. This ſalt is likewiſe completely ſoluble in alcohol.

§ CCCXXXVII. Muriate of lime is decompounded by ponderous earth and the cauſtic fixed alkalis, becauſe they have a greater affinity for the muriatic acid than lime. The fixed aërated alkalis likewiſe decompound it by double affinity; carbonate of ammoniac, however, only decompoſes it in the moiſt way. If a concentrated ſolution of this ſalt be mixed with a concentrated ſolution of mild pot-aſh, or ſoda, the mild calcareous earth, recently formed, abſorbs the whole of the water, and, in conſequence, the mixture becomes ſolid. This phenomenon was formerly termed *Miraculum chemicum.*

§ CCCXXXVIII. One hundred parts of muriatic acid are ſaturated with 89 parts of cauſtic lime; and 100 parts of cryſtallized muriate of lime contain 42 parts acid, 38 parts lime, and 20 parts water of cryſtallization.

XXXI. OF FLUATE OF LIME.

§ CCCXXXIX. Fluate of lime is an earthy ſalt which conſiſts of lime and the fluoric acid. It is found in great abundance in the veins of metals in England, Saxony, Bohemia, Switzerland, Harz, and elſewhere. We obtain it artificially by direct combination, but not without great difficulty; an eaſier way is to decompoſe nitrate of lime by the fluoric acid.

§ CCCXL. Fluor is difficultly ſoluble in water, and is not therefore eaſily cryſtallized by art. Its cryſtals, in their natural ſtate, appear generally in the form of cubes. In the fire it readily fuſes into a vitreous maſs, without being decompounded. It likewiſe promotes the fuſion of other earths. When heated it emits a phoſphoric light.

§ CCCXLI. One hundred parts of cryſtallized fluor contain, according to Scheele, 16 parts acid, 57 parts lime, and 27 parts water of cryſtallization.

XXXII. OF BORATE OF LIME.

§ CCCXLII. The artificial combination of boracic acid and lime produces borate of lime, an earthy ſalt which has hitherto been but little examined. For this purpoſe either a ſolution of boracic acid is added to lime water, or boracic neutral ſalts are combined with calcareous neutral ſalts.

§ CCCXLIII. Borate of lime is diſſolved in 10 parts of boiling water, and, on cooling the ſolution, ſhoots into white flocculi. It has no taſte. In the fire it becomes a vitreous maſs.

XXXIII. OF CARBONATE OF LIME.

§ CCCXLIV. Carbonate of lime, aërated lime, mild calcareous earth, or lime-ſtone, is a true earthy ſalt, ariſing from the combination of carbonic acid and lime. It is found in ſuch abundance that it may be properly conſidered as a conſtituent part of our earth, immenſe chains of mountains being formed by it.— On account of its external form, mineralogiſts have diſtinguiſhed it by various names, ſuch as Chalk, Marble, Spar, &c. It is produced artificially either by direct combination, or by the decompoſition of neutral carbonates by lime.

§ CCCXLV. As carbonate of lime is ſcarcely ſoluble in water, it has never been cryſtallized by art; in nature, however, it is found in a cryſtallized ſtate, under a great variety of forms. In the fire it undergoes no alteration at firſt, but, at laſt, if the heat be intenſe, it is decompounded, the acid eſcapes, and the lime remains in a cauſtic ſtate. Thus common lime-ſtone, when burnt in lime-kilns, becomes quick-lime.

§ CCCXLVI. Almoſt all acids decompound the mild calcareous earth; new calcareous ſalts are formed, and the carbonic acid paſſes off in the ſtate of carbonic acid gaz, whence ariſes the efferveſcence.

§ CCCXLVII. Water, when impregnated with the carbonic acid, diſſolves a much greater quantity of mild calcareous earth, and forms acidulous carbonate of lime. But, by heat or repoſe, the ſuperabundant carbonic acid is again ſeparated, and mild calcareous earth precipitated.

XXXIV. OF BARYT.

§ CCCXLVIII. Baryt, or pure ponderous earth, has not hitherto been found in nature, for it is always combined either with the ſulphuric acid, in the ſtate of ponderous ſpar, or with the carbonic acid, as carbonate of baryt. We produce it artificially, by the decompoſition of ponderous ſpar by fixed alkalis. To this end, one part of ponderous ſpar, and three parts of mild pot-aſh, are put into a crucible, and ſtrongly heated for ſome time; the ſulphate of pot-aſh thus formed, being then waſhed in water, the carbonate of baryt remains. To aſcertain whether this carbonate be perfectly free from undecompoſed ponderous ſpar, we diſſolve it in nitric acid, filtrate the ſolution, and precipitate the baryt by means of mild ſoda; the carbonic acid being then expelled by calcination, pure or cauſtic ponderous earth is obtained.

§ CCCXLIX. Pure baryt, like quicklime, is cauſtic. Its ſpecific gravity is equal to 4. It is completely diſſolved in 900 parts of diſtilled water, and affords a liquid ſimilar to that of lime. In the fire it does not melt by itſelf.

XXXV. OF SULPHATE OF BARYT.

§ CCCL. Sulphate of baryt, or ponderous ſpar, is an earthy ſalt, compoſed of the ſulphuric acid and pure baryt. It is abundantly found in the veins of metals in almoſt every part of Europe. We obtain it artificially by the decompoſition of other barytic ſalts by the ſulphuric acid.

§ CCCLI. Nature frequently affords this neutral ſalt in a cryſtallized ſtate, and generally, in the form of ſmall rhomboidal plates. At firſt it undergoes ſcarcely any alteration in the fire, but, at length, it melts into glaſs. When heated it becomes luminous in the dark. It is almoſt inſoluble in water, at leaſt, it is leſs ſoluble than gypſum.

§ CCCLII. Neither cauſtic alkalis nor the other mineral acids have any action upon ponderous ſpar. Ærated neutral ſalts decompoſe it by double affinity, for the ſulphuric acid combines with the alkalis, and the carbonic acid with the ponderous earth, forming carbonate of baryt.

§ CCCLIII. According to Hermbſtaedt, 100 parts of ſulphuric acid are required for the perfect ſaturation of 330 parts of ponderous earth; and 100 parts of ponderous earth contain 30 parts acid, 67 parts baryt, and 3 parts water.

XXXVI. OF NITRATE OF BARYT.

§ CCCLIV. Nitrate of baryt, or nitrated baryt, is an earthy ſalt, conſiſting of the nitric acid and ponderous earth. It has not hitherto been found in nature. Art forms it either by direct combination, or the decompoſition of carbonate of baryt by the nitric acid.

§ CCCLV. According to ſome Chemiſts, the cryſtals of nitrate of baryt are ſix-ſided columns; according to others, triaëdral plates. It has an acrid and bitter taſte, and is not changed in the atmoſphere. It is decompounded in the fire as well as its acid; the latter comes over in the ſtate of oxygen and nitrogen gazes, and pure ponderous earth remains. Six parts of cold water, at leaſt, are required for its ſolution.

§ CCCLVI. The other earths and cauſtic alkalis have no effect upon nitrate of baryt; the mild alkalis, however, decompoſe it by double affinity. The nitric acid combines with the cauſtic alkalis, and the carbonic acid with the ponderous earth. It is alſo decompounded by the ſulphuric acid, which, uniting with the ponderous earth, forms artificial ponderous ſpar, whilſt the nitric acid is expelled.

§ CCCLVII. Nitrate of baryt, on account of this latter property, is an excellent mean for deteſting ſulphuric acid in liquids, and, like nitrate of ſilver, may be employed to purify the nitric acid from ſulphuric acid. Laſtly, as nitrate of baryt decompoſes neutral ſulphates, it is very uſeful for detecting the preſence of ſuch bodies.

XXXVII. OF MURIATE OF BARYT.

§ CCCLVIII. Muriate of baryt is an earthy ſalt, which ariſes from the combination of baryt and the muriatic acid. Hitherto we have not found it in nature, but we obtain it artificially, either by the direct combination of its conſtituent parts, or by the decompoſition of carbonate of baryt, by means of the muriatic acid.

§ CCCLIX. The cryſtals of this neutral ſalt are cubes, which remain unchanged in atmoſpheric air, and have a nauſeous and burning taſte. They undergo no alteration in the fire. Three parts of cold water are required for their ſolution.

§ CCCLX. Cauſtic alkalis, and alkaline earths, have no action upon this ſalt; but mild alkalis decompound it by double affinity. It is likewiſe decompoſed by the ſulphuric and fluoric acids; and, of all the ſalts with which we are acquainted, it is the moſt uſeful for detecting the preſence of thoſe acids.

XXXVIII. OF CARBONATE OF BARYT.

§ CCCLXI. Carbonate of baryt, or aërated ponderous earth, is an earthy ſalt, formed of the carbonic acid and pure ponderous earth. It has been found ready formed near Angleſark in Lancaſhire, and near Strontian in Scotland. It is obtained artificially by the decompoſition of mild alkalis by means of pure ponderous earth.

§ CCCLXII. Though aërated ponderous earth be found in nature in the form of priſmatic cryſtals with pyramidal extremities, yet we have never been able to obtain it in that ſtate by art. Its ſpecific gravity is 3.773. It has no taſte, and is not altered in the atmoſphere. It is decompounded in the fire; the carbonic acid eſcapes in the ſtate of gaz, and pure ponderous earth remains. It is almoſt inſoluble in water, for water, even if it be impregnated with carbonic acid, diſſolves no more than $\frac{1}{1550}$ part of it.

§ CCCLXIII. All mineral acids decompound this ſalt; they combine with the pure ponderous earth, and form new neutral ſalts, while the carbonic acid is ſeparated. But no effect is produced upon it by the cauſtic alkalis and the other earths.

§ CCCLXIV. One hundred parts of carbonate of baryt contain 65 parts of pure baryt, 28 parts of carbonic acid, and 7 parts of water.

XXXIX. OF MAGNESIA.

§ CCCLXV. Pure Magneſia, or bitter earth, has not hitherto occurred in nature, for it is combined either with acids in the form of earthy ſalts, or mixed with other earths, as Serpentine, Steatites, Talc, Aſbeſtos, &c. For chemical and medical purpoſes it is commonly prepared by the decompoſition of bitter ſalt, by the fixed mild alkalis, and ſubſequent ſeparation of the carbonic acid by calcination.

§ CCCLXVI. Magneſia when pure and perfectly free from acid has no taſte. It imparts a faint green to blue vegetable juices, and is ſcarcely ſoluble in water, for no leſs than 7692 parts of it are required for the complete ſolution of one part of pure magneſia, nor does it become hot with it. Fire does not change it in the leaſt, and, if pure, it reſiſts the moſt intenſe heat*. It is not diſſolved by ſiliceous earth, but with calcareous earth it melts into glaſs which ſcintillates with ſteel. It vitrifies alſo with borax and microcoſmic ſalt.

XL. OF SULPHATE OF MAGNESA.

§ CCCLXVII. Sulphate of magneſia, Sal amarus, Epſom ſalt, is an earthy ſalt, which conſiſts of the ſulphuric acid and pure magneſia. It exiſts in various mineral waters, ſuch as the waters of Epſom, Seydſchitz, Eger, and others. It occurs likewiſe, under a ſolid form, in the fiſſures of rocks among the Alps in Switzerland, and various other mountains, and in the caverns near Jena, called *Teufelslöcher*. We obtain it artificially either by direct combination or the decompoſition of ſuch other earthy ſalts as contain magneſia, by the ſulphuric acid.

---

* It is ſaid, that, at Chemnitz in Lower Hungary, metallic reguli have lately been obtained from Chalk, Baryt, and Magneſia.

T.

§ CCCLXVIII. The cryſtals of ſulphate of magneſia are properly four-ſided columns, with four-ſided extremities; but, in general, it only ſhoots into ſmall needle-like cryſtals. It has a very bitter taſte, and loſes its tranſparency when in contact with the open air. On expoſure to fire, it parts with its water of cryſtallization, and falls to powder: if water be then affuſed, the ſalt eagerly abſorbs a part of it, with developement of much heat, and becomes a ſolid maſs, which is gradually diſſolved in the remaining water; but, if the ſalt be kept longer in the fire, it melts, is decompounded, and the ſulphuric acid eſcapes.

§ CCCLXIX. One thouſand parts of cold water readily diſſolve about 800 parts of ſulphate of magneſia; but 1000 parts of this ſalt are perfectly diſſolved in only 666 parts of boiling water.

§ CCCLXX. Sulphate of magneſia is decompoſed by pure calcareous and ponderous earths; they combine with the ſulphuric acid and form gypſum, or ponderous ſpar, and the magneſia is ſeparated. If, therefore, lime-water be poured into a ſolution of ſulphate of magneſia, the precipitate will conſiſt of gypſum and magneſia.

§ CCCLXXI. Sulphate of magneſia is decompounded by the fixed cauſtic alkalis, which combine with its acid, and form ſulphate of pot-aſh or ſoda, and pure magneſia is precipitated. Bitter ſalt is alſo decompounded by cauſtic ammoniac; this body combines with the ſulphuric acid and forms ſulphate of ammoniac, which, however, inſtantly ſeizes upon the precipitated magneſia, and forms a triple ſalt. The mild alkalis decompoſe ſulphate of magneſia by double affinity; and, on this occaſion, the carbonic acid, which is ſeparated, unites with the pure magneſia and forms carbonate of magneſia.

§ CCCLXXII. One hundred parts of ſulphuric acid are ſaturated with 80 parts of magneſia, and 100 parts of cryſtallized ſulphate of magneſia contain 24 parts acid, 19 parts magneſia, and 57 parts water of cryſtallization.

XLI. OF NITRATE OF MAGNESIA.

§ CCCLXXIII. Nitrate of magneſia, or nitrated magneſia, is an earthy ſalt, compoſed of the nitric acid and pure magneſia. It is found native in the mother earth of nitre-manufactories, and on walls. We obtain it artificially either by direct or indirect combination.

§ CCCLXXIV. It difficultly ſhoots into cryſtals which are tetraëdral columns; its taſte is acrid and bitter, and it deliqueſces in the atmoſphere. It is decompounded in the fire; the acid is expelled in the ſtate of oxygen and nitrogen gazes, and pure magneſia remains. It is readily diſſolved in water, and, likewiſe, in ſpirit of wine; the former diſſolves its own weight.

§ CCCLXXV. Nitrate of magneſia is decompounded by quicklime, pure baryt, and pure alkalis, which precipitate pure magneſia. The mild alkalis precipitate the magneſia in a mild ſtate. A decompoſition of this ſalt is alſo effected by the ſulphuric and fluoric acids, which combine with the magneſia, and expel the nitric acid.

§ CCCLXXVI. One hundred parts of nitric acid require 75 parts of pure magneſia for perfect ſaturation, and 100 parts of cryſtallized nitrate of magneſia contain 36 parts of acid, 27 parts of magneſia, and 37 parts water of cryſtallization.

XLII. OF MURIATE OF MAGNESIA.

§ CCCLXXVII. Muriate of magneſia is an earthy ſalt, which conſiſts of the muriatic acid and pure magneſia. In its native ſtate it is found in ſea-water, in various mineral waters, and in the mother-earth of nitre manufactories. It is produced artificially, either by direct or indirect combination.

§ CCCLXXVIII. This ſalt is formed in very delicate acicular cryſtals, which deliqueſce on expoſure to the atmoſphere, and have an acrid and bitter taſte. Fire decompoſes it, the acid eſcapes, and pure magneſia remains.

§ CCCLXXIX. It is readily diſſolved in its own weight of water; nevertheleſs its cryſtallization is attended with difficulty, and the liquor, on being cooled, generally forms a gelatinous maſs.

§ CCCLXXX. This ſalt is perfectly decompoſed by quicklime, pure baryt, and the fixed cauſtic alkalis. With pure ammoniac it forms a triple ſalt. It is alſo decompoſed by the ſulphuric and nitric acids, and the muriatic acid is ſeparated.

§ CCCLXXXI. One hundred parts of muriatic acid are completely ſaturated with 71 parts of pure magneſia, and 100 parts of muriate of magneſia conſiſt, according to Bergmann, of 34 parts acid, 41 parts magneſia, and 25 parts of water of cryſtallization.

XLIII. OF CARBONATE OF MAGNESIA.

§ CCCLXXXII. Carbonate of magneſia, or aërated magneſia, is an earthy ſalt formed of the carbonic acid and pure magneſia. We find it in a ſtate of combination with other earths, in Serpentine, Talc, &c. It is obtained artificially by the decompoſition of neutral magneſian ſalts by means of mild alkalis.

§ CCCLXXXIII. Completely aërated magneſia is formed (but ſeldom) in minute acicular cryſtals.—

Its ſpecific gravity is 2.155. It has an earthy taſte, and ſuffers no change in the atmoſphere. It is decompounded in the fire, the carbonic acid is expelled, and pure magneſia remains, which has ſuffered a loſs of weight equal to 0.55. This ſalt is taken up by cold diſtilled water in a proportion of $\frac{9}{1000}$, but if impregnated with carbonic acid $\frac{6}{845}$.

§ CCCLXXXIV. All the other mineral acids decompoſe carbonate of magneſia with effervеſcence. Siliceous earth, by itſelf, does not decompound it in the dry way; but mixed with ſiliceous and calcareous earths, it melts into a glaſs which ſcintillates with ſteel.

§ CCCLXXXV. One hundred parts of carbonate of magneſia contain 45 parts of pure magneſia, 25 parts of carbonic acid, and 30 parts of water.

XLIV. OF ALUMINE.

§ CCCLXXXVI. Alumine, aluminous or argillaceous earth, has not hitherto been found perfectly pure in nature, but always in a ſtate of mixture with other earths. The pureſt is found near Halle in the Duchy of Magdeburgh. It is eaſily obtained artificially, by the decompoſition of alum by means of alkalis

§ CCCLXXXVII. The ſpecific gravity of pure alumine is 2. It has no taſte, and is inſoluble in water, although water divides it into minute particles, and forms with it a ſoft and tenacious maſs, which is happily adapted for the baſes of pigments. It undergoes no change in the atmoſphere, nor does it attract carbonic acid. In the fire it is not fuſed in the leaſt, but greatly diminiſhed in volume, whence the ingenious Mr. Wedgwood made uſe of this earth for his pyrometer. When fuſed with three parts of calcareous earth, it affords glaſs which ſcintillates with ſteel. The fixed alkalis likewiſe diſſolve it in the dry way, and thus forms a maſs ſoluble in water.

XLV. OF ALUM.

§ CCCLXXXVIII. Alum, or ſulphate of alumine, is an earthy ſalt which conſiſts of the ſulphuric acid and alumine. Native alum is found near the craters of volcanos, and in ſome mineral-waters. We obtain it artificially, either by direct combination, or by the reduction of aluminous pyrites.

§ CCCLXXXIX. Theſe minerals always contain the chief conſtituents of alum in an uncombined ſtate. The ſulphuric acid appears in the form of ſulphur, and the alumine is combined with various other bodies. But, during the efflorefcence, the ſulphur combines with the oxygen of the atmoſphere, and forms ſulphuric acid, which, uniting with the alumine, becomes alum. To accelerate this proceſs, a large quantity of the minerals ſhould be previouſly roaſted by a gentle heat, to purify them from all reſinous matter.

§ CCCXC. The ſulphuric acid, generated in the manner deſcribed, combines not only with the alumine, but alſo with the calcareous earth, magneſia, and iron of the minerals, and produces gypſum, ſulphate of magneſia, and ſulphate of iron. The alum is ſeparated from theſe bodies by cryſtallization; the gypſum is precipitated during evaporation, and the ſulphates of magneſia and of iron remain in the lie.

§ CCCXCI. Beſides thoſe impurities, the firſt lixivium of alum contains alſo a certain portion of ſuperabundant ſulphuric acid, which impedes the cryſtallization of the alum. This is generally ſaturated with pot-aſh. Nevertheleſs the alum of the ſhops is not only ſuperſaturated with ſulphuric acid, but alſo mixed with ſulphate of pot-aſh.

§ CCCXCII. The cryſtals of alum are octaëdrons of a ſweetiſh aſtringent taſte, which effloreſce in a ſlight degree when in contact with the atmoſphere, and change the infuſion of violets red. On expoſure to fire they liquefy very readily, loſe their water of cryſtallization with conſiderable intumeſcence, and form a dry, friable, and ſpongy ſubſtance, termed burnt alum. It is decompounded if the heat be more intenſe, its acid is diſſipated, and alumine remains. It requires 34 parts of cold, and 16 parts of boiling water for ſolution.

§ CCCXCIII. Alum is decompounded by lime, baryt, and magneſia, which combine with the ſulphuric acid, and precipitate the alumine. The ſame effect is produced by pure alkalis, but, if they be added to exceſs, the alumine which was precipitated is re-diſſolved.

§ CCCXCIV. If a ſolution of common alum be boiled with a ſmall portion of alumine, the alum appears not only to be perfectly ſaturated with the earth, but to be ſuperſaturated. The lixivium is then almoſt taſteleſs, and when at reſt depoſits cryſtals of a cubic form.

§ CCCXCV. One hundred parts of ſulphuric acid are ſaturated with 75 parts of alumine, and 100 parts of the cryſtals of alum contain 24 parts acid, 18 parts alumine, and 58 parts of water of cryſtallization.

XLVI. OF THE OTHER ALUMINOUS NEUTRAL SALTS.

§ CCCXCVI. The combination of 100 parts of nitric acid and 65 parts of alumine produces an earthy ſalt, viz. nitrate of alumine, the cryſtals of which repreſent ſmall priſms; they have an aſtringent taſte, and deliqueſce in the atmoſphere. In the fire they ſwell, and are, at laſt, decompounded, on which occaſion their acid eſcapes in the ſtate of oxygen and nitrogen gazes.

§ CCCXCVII. One hundred parts of muriatic acid, combined with 55 parts of alumine, afford an earthy ſalt, known by the name of muriate of alumine. It is difficultly cryſtallizable. If the lixivium be evaporated to dryneſs, there generally remains a maſs ſimilar to gum, which has a ſaline aſtringent taſte, and is very deliqueſcent in the atmoſphere.—

Expoſed to fire, it loſes its acid and is decompounded.

§ CCCXCVIII. If a ſolution of mild pot-aſh, or ſoda, be poured into a ſolution of common alum, no immediate precipitation takes place, but the carbonic acid, ſeparated from the alkalis, combines with the alumine, and produces a neutral ſalt ſoluble in water, but which is decompounded when at reſt, pure alumine being precipitated, and the carbonic acid expelled. This carbonate of alumine is ſaid to be alſo a natural product.

XLVII. OF SILEX.

§ CCCXCIX. Silex, or ſiliceous earth, occurs more frequently and much purer in nature than the other earths. Mineralogiſts have diſtinguiſhed it by various names, according to its external appearance, and its greater or leſs purity. Thoſe earths and ſtones which contain it in abundance are termed vitrifiable earths and ſtones. It is found ſtill purer in what is termed white quarz.

§ CCCC. No ſpecies of ſilex is perfectly pure; it is mixed either with metals or other earths. In order, therefore, to obtain pure ſilex for chemical purpoſes, we reduce one part of quarz to an impalpable powder, and fuſe it in a crucible with four parts of pure pot-aſh, by which means we obtain a vitreous maſs, which ſpeedily deliqueſces in the atmoſphere, and which, diſſolved in two parts of water, furniſhes the liquor of flints. This liquor, being diluted with 24 parts of water, nitric acid is ſucceſſively added, till the mixture becomes acid to the taſte. It is then evaporated, and we find that the reſidue is a delicate powder, which, waſhed and edulcorated, forms pure ſilex.

§ CCCCI. If the liquor of flints, above-mentioned, be diluted with a ſmall quantity of water only, and an acid be then added, the ſilex is immediately ſeparated in the form of a viſcous maſs, which is difficultly ſeparated from the remaining liquid.

§ CCCCII. The hardneſs of ſilex is ſuch as to ſcintillate with ſteel. Its ſpecific gravity is 2.265. It ſuffers no change in the atmoſphere, and, if perfectly pure, may be expoſed to the moſt violent heat without being fuſed. It is almoſt inſoluble in water, for 100,000 parts of water can hold no more than one part of ſilex in ſolution.

§ CCCCIII. Silex is neither eroded nor diſſolved by any acid, the fluoric acid excepted. The cauſtic fixed alkalis diſſolve it in the dry way. Two parts of ſilex, combined with one part of alkali,, form a maſs inſoluble in water, termed glaſs. But four parts of alkali, and one part of ſilex, afford a glaſs which is ſoluble in water. (§ CCCC.) It alſo combines with lime, and thus produces an opaque glaſs.

§ CCCCIV. In the moiſt way, ſilex is diſſolved by the cauſtic alkalis, for ſix or ſeven parts of theſe hold one part of ſilex in ſolution; but, on the addition of carbonic, or other acids, the ſilex is again ſeparated.

XLVIII. OF JARGON.

§ CCCCV. The celebrated Klaproth in analyzing the precious ſtone known to mineralogiſts by the name of jargon, diſcovered a peculiar ſpecies of earth as one of its conſtituent parts, which differs in its chemical properties from all the other known earths, and to which he gave the name of *Terra circonia.*

§ CCCCVI. This earth is not diſſolved by the cauſtic alkalis either in the dry or moiſt way. The ſulphuric acid, however, diſſolves it completely without efferveſcence, and forms, after evaporation, a pultaceous maſs with it. If it be ſuperſaturated with this acid, it becomes a cryſtallizable ſalt of an aſtringent taſte. Borax diſſolves it in the dry way.

XLIX. OF THE EARTH OF ADAMANTINE SPAR.

§ CCCCVII. Adamantine ſpar, according to Klaproth, conſiſts of argil and a peculiar ſpecies of earth, which differs from all the other known earths in its property of not being diſſolved by acids in the moiſt way, nor by the alkalis in the dry way. Klaproth termed it Earth of adamantine ſpar. Its properties are not yet accurately aſcertained.

Since the original was publiſhed (1793) a new earth has been diſcovered in the mines of Strontian, in Argyleſhire, termed Strontite or Strontian earth. It has a pungent acrid taſte, is ſoluble both in hot and cold water, but more readily in the former, and cryſtallizes on cooling the ſolution. It attracts carbonic acid from the atmoſphere, and combines with various acids. *Vide the Tranſactions of the Royal Society of Edinburgh.* T.

L. OF INFLAMMABLE BODIES.

§ CCCCVIII. Though, ſtrictly ſpeaking, all bodies may be ſaid to be combuſtible which are capable of combining with oxygen, yet, in this place, we diſtinguiſh by that name ſuch bodies of the mineral kingdom only as burn with facility and flame in an increaſed temperature. Theſe may be divided into ſimple and compound. The diamond and ſulphur belong to the former, and, to the latter, ſolid and liquid bitumens.

LI. OF THE DIAMOND.

§ CCCCIX. The diamond is found in the kingdoms of Viſapour and Golconda in the Eaſt Indies, and, likewiſe, in Brazil. It appears in the form of octaëdral, dodecaëdral, and icoſaëdral cryſtals, and generally ſurrounded by an earthy cruſt. This precious ſtone was formerly ranked among vitreous bodies; but, it has been ſince proved by experiments that it is, in reality, an inflammable ſubſtance. We are not, however, acquainted with its conſtituent parts, and all we know of its properties is limited to this.

§ CCCCX. The diamond is one of the hardeſt bodies in nature. It ſpecific gravity is 3.5212. It reflects the rays of light in a triple ratio of its denſity. It diſſilates when ſuddenly expoſed to fire; but, if it be heated gradually, it burns ſlowly, and with a phoſphoric light in the temperature at which ſilver melts, without the ſmalleſt reſidue. If the combuſtion take place in a cloſe veſſel, it produces a very ſmall quantity of carbonic acid. But, neither water, ſpirit of wine, oils, nor ſalts, either in the dry or moiſt way, have the leaſt effect upon it.

LII. OF SULPHUR.

§ CCCCXI. Nature abounds with ſulphur, both pure and in a ſtate of mixture with other bodies. The former is found near the craters of volcanos, and the ſources of ſome mineral waters; and, in larger maſſes, mixed with gypſum and calcareous earth, in Sicily, Spain, Switzerland, and other countries. The latter is found in metallic ores, and, combined with hydrogen and lime, in various mineral waters. The ſulphur of commerce is either ſuch as is found ready formed, or ſuch as is extracted from copper or iron pyrites. Of late it has been aſſerted, that ſulphur is often ſeparated during the putrefaction of animal and vegetable matter, and even that it has been extracted from them by chemical means.

§ CCCCXII. Sulphur has a yellow colour, and poſſeſſes neither taſte nor ſmell. Its ſpecific gravity is from 1. 900. to 2. 350. It undergoes no change in air, and is inſoluble in water. Spirit of wine does not diſſolve it, unleſs both bodies be reduced to the ſtate of gaz; in this caſe, 12 parts of ſpirit of wine diſſolve one part of ſulphur.

§ CCCCXIII. A gentle heat changes it into phoſphoreſcent vapours; but, if the heat be increaſed, it becomes ſoft, fuſes, and aſſumes a red colour, and, when cooled, ſhoots into acicular cryſtals. As the earthy particles with which the ſulphur is mixed are not volatile, it can be purified by ſublimation, when flowers of ſulphur are obtained. This operation is uſually performed in veſſels called aludels.

§ CCCCXIV. If ſulphur be more ſtrongly heated in an open veſſel, it accends with a blue flame. This combuſtion abſolutely requires a free acceſs of atmoſpheric air. The vapours, which then ariſe, are very ſuffocating, and, collected in a proper apparatus, conſtitute an æriform acid of a peculiar kind, termed ſulphuric or vitriolic acid. Sulphur, till within theſe few years, was thought to be a compound body, the conſtituent parts of which were ſaid to be vitriolic acid and phlogiſton; but, it can now be demonſtrated by experiment, that ſulphur is a ſimple body, which, during combuſtion, or, in other words, during its combination with oxygen, produces ſulphuric acid.

LIII. OF ACIDS OF SULPHUR IN GENERAL.

§ CCCCXV. Sulphuric or vitriolic acid conſiſts, therefore, of ſulphur, which conſtitutes its baſis, and of oxygen. It frequently occurs in combination with alkalis, earths, and metals; but ſeldom in a ſtate of purity, and whether at all has been doubted. For chemical, medical, and other purpoſes, it is obtained by the combuſtion of ſulphur, and the decompoſition of metallic and earthy ſulphuric acid ſalts by fire.

§ CCCCXVI. Hence, if calcined ſulphate of iron be diſtilled in an earthen or glaſs retort, carefully luted, the ſulphuric acid, ſtill united with the remaining water of cryſtallization, is obtained in the receiver, and a red oxide of iron is left in the retort. It can be produced in the ſame manner from alum, but, in this caſe, the reſidue is pure alumine. Concentrated ſulphuric acid, obtained by this proceſs, is commonly termed oil of vitriol, or oil of alum.

§ CCCCXVII. But, if ſulphur be burned under a ſpacious bell-glaſs, the internal ſurface of which being moiſtened by the vapours of water, the ſulphuric acid, formed by the combuſtion of the ſulphur, combines with the water which adheres to the bell, and paſſes into the receiver, and is now termed ſpirit of ſulphur by the bell. For commerce, this acid is prepared by burning ſulphur in a large receptacle, coated on the inſide with ſheets of lead, and furniſhed at the bottom with a ſufficient quantity of water.

§ CCCCXVIII. Sulphuric acid is likewiſe obtained by repeatedly diſtilling pure nitric acid upon powdered ſulphur. During this diſtillation a conſiderable portion of nitrous gaz is ſucceſſively diſengaged, and, at length, pure ſulphuric acid is left in the retort. On this occaſion the nitric acid is decompounded; for one part of its oxygen combines with the ſulphur, and forms ſulphuric acid, while the other part or the nitrous gaz eſcapes.

§ CCCCXIX. Sulphur is capable of combining with oxygen in various proportions, and for this reaſon we have perfect acid of ſulphur, or ſulphuric acid, and imperfect acid of ſulphur, or ſulphureous acid. As theſe acids differ from each other in many of their properties, it will be right to treat of them under different heads.

LIV. OF THE SULPHURIC ACID.

§ CCCCXX. To obtain the ſulphuric acid, or perfect acid of ſulphur in a very pure ſtate, oil of vitriol, ſuch as is uſually had at the ſhops, is diſtilled in a glaſs retort. At firſt, a browniſh liquor paſſes over into the receiver, which, being ſeparated and kept in a cloſe veſſel, ſhoots, by refrigeration, into glacial cryſtals on the ſides of the veſſel, formerly termed volatile ſalt of vitriol. This liquor is ſucceeded by the water of the oil of vitriol, and, laſtly, on increaſing the heat, by very pure ſulphuric acid. The cryſtallizable liquor before mentioned is not always obtained, and generally only from the oil of vitriol prepared from ſulphate of iron.

§ CCCCXXI. This pure ſulphuric acid is colourleſs, like water, and has no taſte; its ſpecific gravity is from 1.900. to 2.125. It attracts moiſture from the atmoſphere with great avidity. If highly concentrated, it congeals even at a temperature of 15°. and becomes a cryſtalline maſs, formerly termed glacial oil of vitriol. It requires an intenſe heat to be rendered volatile, when it riſes in the form of white and ſuffocating vapours. Mixed with water, it becomes hot, and is then termed ſpirit of vitriol.

§ CCCCXXII. All combuſtible bodies, of any of the three kingdoms, decompoſe the ſulphuric acid when brought into contact with it at a proper temperature. The oxygen of the ſulphuric acid combines either wholly, or in part, with the combuſtible body, and, therefore, what remains is either ſulphureous acid or ſulphur itſelf.

§ CCCCXXIII. The ſulphuric acid abſorbs carbonic acid gaz in conſiderable quantity, and combines with it. Mixed with the muriatic acid, it becomes hot, and emits muriatic acid vapours. It alſo combines with the nitric acid.

§ CCCCXXIV. According to Bertholet, 100 parts of pure ſulphuric acid conſiſt of from 69 to 72 parts of ſulphur, and from 28 to 31 parts of oxygen.

LV. OF THE SULPHUREOUS ACID.

§ CCCCXXV. If, in a glaſs retort, concentrated ſulphuric acid be poured upon pure mercury, and heated, a gaz is ſeparated, which can be received in the hydrargyropneumatic apparatus, known by the name of ſulphureous acid gaz. In the retort there remains a dry white ſubſtance, which is a compound of the ſulphuric acid and oxide of mercury. During this proceſs, a part of the acid is decompounded, its oxygen combines with the mercury, and forms an oxide which is thus diſſolved by the remaining ſulphuric acid, and, therefore, the ſulphuric acid, decompoſed by being in a great meaſure deprived of its oxygen, comes over in the ſtate of ſulphureous acid gaz.

§ CCCCXXVI. Sulphureous acid gaz is equally formed whenever combuſtible bodies are treated with ſulphuric acid, at a ſuitable temperature. In this caſe, the ſulphuric acid is always decompoſed, for a part of its oxygen combines with the combuſtible body, and thus the acid itſelf becomes imperfect.

§ CCCCXXVII. This gazeous body is much heavier than atmoſpheric air. A cubic inch weighs 1.038 of a grain. It is highly detrimental to animal life, and burning bodies are extinguiſhed by it in an inſtant. It changes the infuſion of violets firſt red, and afterwards deſtroys their colour. It is ſlowly abſorbed by water, and the acidulous liquor, thus obtained, is ſulphureous acid in a liquid ſtate.

§ CCCCXXVIII. This liquid ſulphureous acid is much more readily obtained, either by the ſolution of volatile ſalt of vitriol, (§ CCCCXX.) or by digeſting animal and vegetable matter in pure ſulphuric acid. (§ CCCCXXII.) But the moſt eaſy method of obtaining it is by means of a direct combination, that is, when a certain portion of ſulphur is diſſolved in pure ſulphuric acid; in either caſe it is frequently termed volatile ſpirit of ſulphur.

§ CCCCXXIX. Sulphureous acid has a black or dark brown colour, and emits a continued cloud of white and ſuffocating vapours. It becomes very hot when mixed with water, in conſequence of which ſulphureous acid gaz is diſengaged, and diluted nitric acid remains. Upon this principle apothecaries prepare ſpirit of vitriol by diluting common oil of vitriol with a ſufficient quantity of water.

§ CCCCXXX. By means of nitrous gaz, the volatile ſpirit of ſulphur obtains a ſolid and glacial form, which accounts for the appearance of glacial oil of vitriol towards the end of a diſtillation of aqua fortis with ſulphate of iron.

LVI. OF SULPHURETS.

§ CCCCXXXI. Both the fixed and volatile alkalis, and all the alkaline earths, except alumine, are capable of combining with ſulphur, and of forming peculiar compounds, which Chemiſts have diſtinguiſhed by the name of ſulphurets or livers of ſulphur, and which ſeverally differ in their properties according to the alkaline baſes employed.

LVII. OF THE SULPHURETS OF POTASH AND SODA.

§ CCCCXXXII. If two or three parts of pure dry pot-aſh, or ſoda, be well mixed in a glaſs mortar with one part of ſulphur, afterwards melted in a crucible, and then poured upon a ſtone table, we ſhall obtain a maſs of a brown hepatic colour, which has received the name of alkaline liver of ſulphur, or ſulphuret of pot-aſh or ſoda. This ſubſtance is likewiſe formed when arcanum duplicatum or ſal admirabilis is calcined with powdered carbon in a crucible; for, during this proceſs, the carbon combines with the oxygen of the ſulphuric acid, and forms carbonic acid, which is diſſipated in the ſtate of gaz; and the remaining ſulphur, combining with the alkali, becomes liver of ſulphur.

§ CCCCXXXIII. Liver of ſulphur has a brown hepatic colour; it readily attracts moiſture from the atmoſphere, whence it acquires the odour of putrid eggs; it is eaſily diſſolved in water, on which occaſion a peculiar gaz, termed hepatic gaz, is ſeparated. This gazeous fluid is a true inflammable air, containing ſulphur, and termed, on this account, by modern Chemiſts, ſulphurated hydrogen gaz.

§ CCCCXXXIV. The colour of the ſolution of the ſulphuret is either a deep ſcarlet or greeniſh, according as the ſulphuret is recent or old. The ſolution, when cooled, depoſits acicular cryſtals. On expoſure to the atmoſphere it becomes gradually turbid, its ſurface is covered with a pellicle, and a ſmall quantity of ſulphur is ſeparated. This ſulphur combines with the oxygen of the atmoſphere, and forms ſulphuric acid; and thus the ſulphuret is gradually changed into arcanum duplicatum, or ſal mirabilis. As this change is proportioned to the oxygen contained in the atmoſphere, ſulphurets have been employed by Scheele, as an eudiometer. The above change is greatly facilitated by heat.

§ CCCCXXXV. All acids diſſolve ſulphurets; they combine with their alkalis, and produce neutral ſalts, and the ſulphur itſelf is precipitated in the form of a white and impalpable powder. If an aqueous ſolution of ſulphuret be decompounded by the acetic acid, the liquor aſſumes a milky colour; for which reaſon the ancient Chemiſts termed it cream of ſulphur. Scarcely any precipitate is formed by the oxygenated muriatic acid, becauſe the ſuperabundant oxygen, in this caſe, combines with the ſulphur, which is diſengaged, changing it into ſulphuric acid. During theſe decompoſitions a greater or leſs quantity of hepatic gaz is always generated.

§ CCCCXXXVI. As liver of ſulphur, recently prepared and perfectly dry, does not contain hepatic gaz, and as this gaz is produced only either during the ſolution of the ſulphuret in water, its deliqueſcence in the atmoſphere, or decompoſition by acids, it is evident, that the water, preſent in all theſe caſes, contributes to the formation of hepatic gaz. Hence it appears, that the oxygen of the water combines with one part of the ſulphur, and forms ſulphuric acid, and that the other part of the ſulphur is diſſolved by the hydrogen, and thus changed into hepatic gaz. But, as this phenomenon is not obſerved when pure ſulphur is treated with water, it follows, that the affinity of the alkali, contained in the ſulphur, co-operates to form the ſulphuric acid during ſuch change.

§ CCCCXXXVII. The conſtituent parts of hepatic gaz are demonſtrated from its direct compoſition; for, if ſulphur be fuſed in a bell-glaſs, filled with hydrogen gaz, by means of a burning lens, the ſulphur is gradually diſſolved, and the gaz becomes hepatic. It is alſo produced if iron pyrites, or a mixture of iron and ſulphur, be diſſolved in diluted nitric acid.

§ CCCCXXXVIII. Hepatic gaz is heavier than atmoſpheric air, and has a peculiar ſmell, which reſembles that of putrid eggs. It is abſorbed by water; for 100 cubic inches of water imbibe 60 of hepatic gaz. Accended in contact with oxygen gaz, or atmoſpheric air, its flame is of a blue colour.

§ CCCCXXXIX. This gaz, if mixed with atmoſpheric air, or oxygen gaz, is ſlowly decompounded; its hydrogen combines with oxygen, and forms water, and the ſulphur is precipitated. Hepatic gaz, diſſolved in water, is decompounded upon the ſame principle, and this ſhews the reaſon why mineral waters, impregnated with native hepatic gaz, always depoſit a certain quantity of ſulphur. The ſulphureous, nitrous, and oxygenated muriatic acids, on account of their weak affinity for oxygen, decompoſe hepatic gaz ſtill more rapidly; and we have thus found, that one cubic inch of hepatic gaz contains 1-8th of a grain of ſulphur.

LVIII. OF SULPHURET OF AMMONIAC.

§ CCCCXL. Though pure ammoniac, or the cauſtic volatile alkali, acts directly, in a ſmall degree, upon ſulphur, yet, as this combination cannot be promoted by heat, on account of the great volatility of pure ammoniac, we are obliged to haſten the combination by other artificial means. Six parts of quicklime, two parts of purified ſal ammoniac, and one part of ſulphur, therefore, being well mixed, and diſtilled in a glaſs retort, adapted to Woulfe's apparatus, with water, produce a yellow and fuming liquor, which, from its inventor, was termed Boyle's, or Beguine's, fuming ſpirit, but which is now called ſulphuret of ammoniac. During this proceſs, the ſal ammoniac is decompounded by the quicklime, and the ammoniac, diſengaged in the ſtate of gaz, diſſolves the ſulphur at the ſame time, and forms volatile liver of ſulphur, or ſulphuret of ammoniac.

§ CCCCXLI. Sulphuret of ammoniac is of a deep yellow colour, and, in contact with the atmoſphere, continually exhales white vapours. Oftentimes it gradually depoſits ſmall needle-like cryſtals, which reflect various colours, and appear to be ſulphuret of ammoniac in a ſolid ſtate. It is decompounded by heat, quicklime, and the fixed alkalis.

§ CCCCXLII. Sulphuret of ammoniac, like ſulphuret of pot-aſh or ſoda, is decompounded by acids, which precipitate the ſulphur, whilſt a very inflammable hepatic gaz is diſengaged. But, if this decompoſition be attempted by concentrated ſulphuric acid, the heat and effervefcence produced is ſo great as not only to throw the whole mixture out of the veſſel, but even to break the veſſel itſelf.

LIX. OF SULPHURET OF LIME.

§ CCCCXLIII. Pure lime readily combines with ſulphur, both in the moiſt and dry way, and forms ſulphuret or hepar of lime. It is prepared in the dry way by calcining two parts of quicklime and one part of ſulphur: but, if water be poured upon a mixture of lime and ſulphur, the ſpontaneous heat, thus excited, will be ſufficient to combine the lime with the ſulphur; and, by filtrating this maſs, we ſhall obtain an aqueous ſolution of ſulphuret of lime.

§ CCCCXLIV. Recent and dry ſulphuret of lime poſſeſſes the property of abſorbing light, and of ſhining in the dark. The ſulphuret prepared from oiſter-ſhells poſſeſſes this property in an eminent degree, and is named after its inventor, Canton's phoſphorus.

§ CCCCXLV. Sulphuret of lime, when expoſed to the atmoſphere, is ſpeedily deprived both of its taſte and ſmell; hepatic gaz is diſengaged, and, at length, mere gypſum remains. The chemical change, which takes place on this occaſion, is the ſame as that in ſulphuret of alkali. If it be ſubjected for ſome time to the action of heat, the ſulphur is inflamed, and changed into ſulphuric acid. The reſidue is, therefore, gypſum.

§ CCCCXLVI. An aqueous ſolution of ſulphuret of lime is more or leſs red, and, if highly ſaturated, and afterwards cooled, it depoſits acicular cryſtals of a yellowiſh red hue; but, on expoſure to the atmoſphere, they gradually loſe their tranſparency and colour. It is decompounded by all the acids; a great quantity of hepatic gaz is produced; and the ſulphur is precipitated in the form of a white powder, which was formerly termed magiſtry of ſulphur.

LX. OF SULPHURET OF BARYT.

§ CCCCXLVII. A combination of baryt with ſulphur is beſt effected by double decompoſition in the dry way. To this end, eight parts of triturated ponderous ſpar are mixed with one part of powdered carbon, and ſtrongly heated in a crucible; thus the carbon combines with the oxygen of the ſulphuric acid, and forms carbonic acid, which eſcapes in an æriform ſtate, and the reſidue is ſulphur, combined with the pure baryt, in the form of ſulphuret of baryt, or liver of baryt.

§ CCCCXLVIII. This ſubſtance is readily diſſolved in water, to which it imparts a deep yellow hue, and, by cooling the ſolution, it yields cryſtals of a yellowiſh colour, which deliqueſce in the atmoſphere, and are at laſt reſolved. Acids decompound it; they diſengage hepatic gaz, and precipitate the ſulphur. If ſulphuric acid be taken for this purpoſe, not only ſulphur, but alſo regenerated ponderous ſpar will be precipitated.

§ CCCCXLIX. Sulphuret of baryt has alſo the property of attracting light, and of ſhining in the dark; and, on this account, it has long been known by the name of bononian phoſphorus. Globules, formed of a mixture of powdered ponderous ſpar and mucilage of gum tragacanth, are uſed for this purpoſe, which are heated in a crucible containing powdered charcoal, by which means they are changed into ſulphuret of baryt.

LXI. OF SULPHURET OF MAGNESIA.

§ CCCCL. To prepare ſulphuret of magneſia, or hepar of magneſia, equal proportions of carbonate of magneſia and of ſulphur are put into a glaſs bottle filled with pure water, which is placed in the water-bath. After ſome time, the water acquires a fœtid hepatic ſmell, and, when cooled, depoſits minute cryſtals. The bottle contains a ſolution of true ſulphuret of magneſia, the ſulphur of which may be again ſeparated by acids.

LXII. OF SAL POLYCHREST.

§ CCCCLI. If pure nitre be fuſed in a crucible, and flowers of ſulphur ſucceſſively added, a ſtrong detonation enſues, which ceaſes, however, after ſome time, and the laſt portion of ſulphur thrown in burns with a gentle flame. The reſidue in the crucible is a grey maſs, which, by protracted calcination, becomes perfectly white, and furniſhes, by ſolution and cryſtallization, a neutral ſalt, which, after its inventor, is termed Glazer's ſal polychreſt. This ſalt is likewiſe prepared by the gradual detonation of equal parts of nitre and ſulphur in a red-hot crucible.

§ CCCCLII. The ſulphur, at this temperature, has a greater affinity with the oxygen of the nitric acid than its own oxygen has, and, therefore, combines with it, and forms ſulphuric acid. But the nitrogen paſſes off in the ſtate of nitrogen gaz, or, if ſtill united to a ſmall portion of oxygen, as nitrous gaz. The ſulphuric acid, thus generated, combines with the pot-aſh, which is now in a free ſtate alſo, and ſal polychreſt is formed.

§ CCCCLIII. This ſalt, therefore, conſiſts of pot-aſh and ſulphuric acid. It differs not in the leaſt from arcanum duplicatum, and is a true ſulphate of pot-aſh. Should the mixture not be ſufficiently calcined after detonation, the ſulphuric acid, recently generated, would either combine with the remaining ſulphur, or, the acid produced, would be ſulphureous acid, and the neutral ſalt obtained ſimilar to Stahl's ſalt of ſulphur, (§ CCXLVII.) or be ſulphate of pot-aſh.

LXIII. OF FULMINATING POWDER.

§ CCCCLIV. If a mixture of one part of flowers of ſulphur, two of dry carbonate of pot-aſh, and three of nitre, be gradually heated in an iron ladle till it begins to melt, at that inſtant an exceedingly ſtrong report is heard, and the whole maſs is ſcattered in every direction. Hence this mixture is generally known by the name of fulminating powder. If it be directly thrown upon burning charcoal, it detonates without any particular report.

§ CCCCLV. As fulminating powder can be produced likewiſe from a mixture of one part of dry ſulphuret and two parts of nitre, the effect of this powder is eaſily explained from the properties which thoſe two bodies exhibit when expoſed to fire. Thus the combination of pot-aſh and ſulphur produces a ſulphuret, which, at this temperature, emits hepatic gaz, and the nitre, fuſed at the ſame time, yields a great quantity of oxygen gaz, which, with the hepatic gaz, forms an extremely inflammable fulminating gaz, included in the very tenacious maſs, till it is burned by a part of the ſulphur, which inflames, whence ariſes the exploſion and diſperſion of the powder. Intumeſcence of the maſs, accompanied by a ſmall portion of flame, immediately precedes this effect.

LXIV. OF GUNPOWDER.

§ CCCCLVI. A mixture of ſulphur, nitre, and powdered carbon, forms gunpowder, ſo well known from its terrible effect, and the uſe to which it is applied. The proportion of its conſtituent parts is not the ſame in all countries, and it varies alſo according to the different purpoſes for which it is intended. In France 100 parts of pure gunpowder contain 75 parts of nitre, $9\frac{1}{2}$ parts of ſulphur, and $15\frac{1}{2}$ parts of powdered carbon.

§ CCCCLVII. In order to prepare gunpowder, the ingredients are firſt pounded by mills conſtructed of wood, and kept continually moiſt with water. The powder, thus formed, poſſeſſes in reality all the properties of good gunpowder, but leſt, on account of its ſubtilty, it ſhould adhere to the gun, when loading, it is uſually granulated. This proceſs conſiſts in preſſing the powder, while moiſt, through leathern ſieves, and afterwards ſifting it, to ſeparate the duſt. For nice purpoſes, and that it may not ſoil the hands, the powder, when granulated, is poliſhed by agitation in a large wooden caſk, which turns upon an axis; it is then carefully dried by the ſun, or in warm rooms.

§ CCCCLVIII. All carbon, that of animals excepted, whether of light or hard wood, is equally fit for the compoſition of gunpowder. Some portion of carbon is indiſpenſably required, for a ſimple mixture of ſulphur and nitre does not by any means produce the deſired effect.

§ CCCCLIX. Gunpowder, ſimply dried, is more powerful than when granulated, for, during granulation, the nitre, on account of the water requiſite for that operation, is cryſtallized, and, conſequently, the ingredients become more unequally mixed. Poliſhed powder is ſtill weaker, becauſe the particles preſs more cloſely upon each other, whence their combuſtion is not ſo inſtantaneous. In general, the quality of gunpowder depends upon the purity and proportion of its component parts, and upon their intimate mixture.

§ CCCCLX. As there is ſuch a great proportion of nitre in gunpowder, and as the ingredients are ſo equally mixed, even the minuteſt particle of the ſulphur and carbon is inveſted with a coat of nitre; and hence, when inflamed, it receives a much greater quantity of oxygen gaz from the nitre than is neceſſary for its perfect combuſtion. The ſulphur and carbon, therefore, burn upon the ſame principle as if immerſed in a veſſel containing oxygen gaz, and are inſtantaneouſly changed into ſulphureous and carbonic acid gazes; to theſe we muſt add the nitrogen gaz produced from the nitre, and the water changed into vapours. Hence it is eaſy to explain not only the rapid combuſtion of gunpowder, even in cloſe veſſels, but alſo its dreadful effect.

§ CCCCLXI. To inſtitute an analyſis of gunpowder, and to aſcertain the proportion of its conſtituent parts, its nitre is firſt waſhed out, and the ſulphur and carbon which remain are afterwards ſeparated by the ſublimation of the ſulphur.

§ CCCCLXII. As the oxygenated muriate of pot-aſh parts with its ſuperabundant oxygen gaz much more readily than nitre, attempts have been made to ſubſtitute it for nitre, in the preparation of gunpowder. The gunpowder formed in this manner proved to be far ſuperior in its effects to common gunpowder, but, at the ſame time, more deſtructive to the gun; for the muriatic acid, diſengaged from the muriate of pot-aſh by the ſulphuric acid, corroded the metal in a much greater degree than the ſulphureous acid, diſengaged from common gunpowder, would have done.

LXV. OF NAPHTHA.

§ CCCCLXIII. Mineralogiſts have given the name of naphtha to a colourleſs and tranſparent fluid, which in ſome parts of Perſia and Italy is found upon the ſurface of ſprings and lakes, and iſſuing from argillaceous ſtones.

§ CCCCLXIV. This ſubſtance has a peculiar ſmell, and does not combine either with water or ſpirit of wine. It is lighter than water, its ſpecific gravity being 0.7. It is inflammable, and, when burned, leaves a black ſoot. If it be diſtilled by a gentle heat, it comes over invariably, without reſidue. Acids condenſe it and render it reſinous. It inflames with fuming ſpirit of nitre.

LXVI. OF PETROLEUM AND MALTA.

§ CCCCLXV. Rock oil, or petroleum, ſeems to differ from naphtha only in its being mixed with heterogeneous matter. It is found in various parts of Europe trickling from the fiſſures of rocks. Its colour is more or leſs brown, inclining to yellow, and its ſmell reſembles that of naphtha. It affords, by diſtillation, at firſt true artificial naphtha, afterwards an oil of a brown colour, and an acidulous water; in the retort there remains a ſmall quantity of carbon, the aſhes of which are mere calcareous earth.

§ CCCCLXVI. Malta is more impure ſtill than petroleum, which conſtitutes the only difference. It has the conſiſtence of honey, is of a black colour, and frequently mixed with much earthy matter. We find it in all thoſe places where petroleum is found.

LXVII. OF ASPHALTUM AND JET.

§ CCCCLXVII. Aſphaltum, or Bitumen of Judea, has derived its name from the Dead Sea in Judea, upon the ſurface of which it is found, and upon the ſhore. It is likewiſe met with in ſeveral other countries. This ſubſtance is ſmooth, brittle, of a black colour, and ſhining fracture. It is inſoluble either in water or ſpirit of wine. It affords, by diſtillation, an acidulous liquid and a ſpecies of artificial petroleum; carbon, mixed with a great portion of earth, remains in the retort.

§ CCCCLXVIII. Jet is a hard, vitreous, black body, ſuſceptible of a high poliſh. In its chemical properties it reſembles aſphaltum, from which it differs merely in its greater hardneſs.

§ CCCCLXIX. Lithantraces, or pitcoal, is found in various parts of Europe in ſtrata beneath the ſurface of the earth. It is a foliated, brittle, black, and glittering ſubſtance, the conſtituent parts of which are petroleum, malta, and aſphaltum, combined more or leſs with other earthy particles, and, frequently, with ſulphur, and the remains of vegetable matter. Hence it has received different names, both in common and from mineralogiſts, as it is more or leſs applicable to various economical purpoſes.

§ CCCCLXX. Good pitcoal burns ſlowly in an open fire, but with a bright flame. It emits a bituminous odour, furniſhes an intenſe and laſting heat, and is at length reduced to mere earthy aſhes. If it be diſtilled from a retort, we obtain a ſmall portion of water, dry ærated ammoniac, a copious quantity of artificial petroleum, and much malta. The reſidue, in the retort, is a black coaly maſs, which affords in the open fire an intenſe heat, but no flame, and burns ultimately to aſhes. In England, this diſtillation is performed in the large way.

LXVIII. OF AMBER.

§ CCCCLXXI. Amber is found in ſeveral countries of Europe beneath the ſurface of the earth, among clay, ſand, and the iron bog-ore, but moſt abundantly in the ſea. The former is termed foſſil-amber, and the latter mineral-amber, which is chiefly gathered on the ſhore of the Baltic, where it is depoſited during tempeſtuous weather, or caught by the inhabitants in nets, placed in a direction contrary to the wind.

§ CCCCLXXII. Amber is met with in irregular maſſes of a white, yellow, or brown colour, and more or leſs tranſparent; red and green amber are very ſcarce. It is taſteleſs; when rubbed, it acquires a faint odour, and at the ſame time obtains a conſiderable degree of electricity. It is not diſſolved in water, and but in a very ſlight degree in ſpirit of wine, unleſs you make uſe of pot-aſh, when the ſolution is termed tincture of amber.

§ CCCCLXXIII. Amber is very ſoluble in expreſſed oils, aſſiſted by heat. This ſolution being diluted with oil of turpentine forms amber-varniſh. The ſolution of amber in the ſulphuric acid is at firſt red, and afterwards black.

§ CCCCLXXIV. Amber diſtilled *per ſe*, in a retort, affords at firſt an acidulous phlegm, afterwards a light oil, which gradually becomes dark, and towards the end of the operation black and viſcid. At the ſame time, a ſalt, which is an acid of a peculiar kind, termed ſuccinic acid, or acid of amber, is ſublimed in the neck of the retort. The reſidue is a glittering coaly maſs.

§ CCCCLXXV. Oil of amber becomes colourleſs by repeated diſtillation with water or clay, and ultimately as limpid as water. In this ſtate, it is termed rectified oil of amber. Rouelle propoſes to obtain ſuch oil during one operation only, which conſiſts in diſtilling oil of amber with a conſiderable quantity of water, from a glaſs cucurbit, in the water-bath.

§ CCCCLXXVI. The ſuccinic acid is rendered quite colourleſs, and free from oil, by repeated ſolutions in water and cryſtallization. The ſame effect is produced by ſublimation with clay or culinary ſalt. But, according to Hermſtaedt, the moſt eaſy method conſiſts in adding two parts of diluted nitric acid to the ſalt of amber, and diſtilling the mixture in a retort. Thus the nitric acid is decompounded, and comes over chiefly in the ſtate of nitrous gaz; but the ſuccinic acid remains in beautiful white cryſtals.

§ CCCCLXXVII. Pure ſuccinic acid forms three-ſided columnar cryſtals. It requires 10 parts of cold, and only two parts of boiling water for ſolution. Hot ſpirit of wine diſſolves more than half its weight. On expoſure to fire, it firſt melts, but ſoon after riſes in the form of white and ſuffocating vapours.

§ CCCCLXXVIII. Succinic acid, combined with ſoda, conſtitutes a neutral ſalt, which ſhoots into three-ſided priſmatic cryſtals, not deliqueſcent in the atmoſphere. With pot-aſh, however, it generates a neutral ſalt, which is deliqueſcent, and of a bitter taſte. Both theſe ſalts are decompounded in fire, and part with their acid. With pure ammoniac, the ſuccinic acid forms a deliqueſcent neutral ſalt, which ſhoots into ſmall acicular cryſtals, and is perfectly ſublimed by heat. But, if ammoniac, ſtill impure from combination with animal oil, or common ſpirit of hartſhorn, be combined with ſuccinic acid, containing oil of amber, we ſhall obtain, what is termed, ſuccinated liquor of hartſhorn.

§ CCCCLXXIX. Succinic acid, combined with lime and baryt, furniſhes a cryſtallizable ſalt, extremely difficult of ſolution in water, and unchangeable in atmoſpheric air. With magneſia it produces a ſalt, which is not cryſtallizable, but deliqueſcent. With alumine, we obtain a ſalt, which has priſmatic cryſtals, and which is unchangeable in the air. Theſe ſeveral ſalts are decompounded by fire, on which occaſion they part with their acid.

§ CCCCLXXX. From theſe experiments it appears, that amber is one of the pureſt bitumens, conſiſting almoſt entirely of a volatile oil, which receives its conſiſtence from a peculiar acid, and of a few earthy and coaly particles. The baſis of the acid of amber, however, is as yet but imperfectly known.

§ CCCCLXXXI. From the combination of rectified oil of amber with pure ammoniac, and a ſmall quantity of ſoap, diſſolved in ſpirit of wine, we obtain the liquor ſo well known by the name of Eau de Luce. For this purpoſe diſſolve ten or twelve grains of ſoap in four ounces of concentrated alcohol; add one dram of rectified oil of amber, and, laſtly, as much cauſtic ſpirit of ſal ammoniac as may give the mixture a milky colour.

LXIX. OF AMBERGRIS.

§ CCCCLXXXII. Ambergris is a very light aſh-coloured body, found in the Eaſt Indies upon the ſea-ſhores. It has a moſt grateful ſmell, even when burned. It becomes ſoft, like wax, on the application of a gentle heat; and, affords by dry diſtillation, a peculiar acid, very ſimilar to that of amber, both liquid and dry; alſo an oil of a yellow colour not diſagreeable to the ſmell; and a ſmall quantity of carbon is left in the retort.

§ CCCCLXXXIII. Ambergris is but imperfectly diſſolved in pure ſpirit of wine; but if this be combined with pot-aſh, the ſolution of the former will be perfect. Fixed and volatile oils, in like manner, diſſolve it only in part. Its beſt menſtruum is ſulphuric ether.

CLX. OF COPAL.

§ CCCCLXXXIV. Copal, or gum-copal, is imported from Guinea, where it is found in the ſand on the ſhore. In its external appearance it reſembles amber, but is commonly more brittle, and rather of a lighter colour. It affords, by diſtillation, a ſmall portion of inſipid water, and a white oil, which, towards the end of the operation, becomes ſomewhat brown; but we obtain no ſalt. In the retort remains a ſpungy coal, the aſhes of which do not yield any ſalt.

§ CCCCLXXXV. Copal is almoſt inſoluble in water, and ſpirit of wine only diſſolves it in part.— Fat oils diſſolve it, when, by previous and continued fuſion, it has acquired a brown red colour. Volatile oils and ſulphuric ether diſſolve it completely, and with facility. With the ſulphuric acid it forms a dark red ſolution of a ſulphureous ſmell. Fuming nitric acid, during a copious diſengagement of nitrous gaz, gives a ſolution of a light brown colour. No effect whatever is produced upon copal by the muriatic acid.

LXXI. OF METALS.

§ CCCCLXXXVI. Metals principally differ from all other bodies on account of their perfect opacity and conſequent metallic ſplendour, their denſity, and ſpecific gravity. In their pureſt metallic ſtate they poſſeſs neither taſte nor ſmell.

§ CCCCLXXXVII. Metals are found in the bowels of the earth, either native, that is, almoſt pure; or, in the ſtate of oxide, that is, under the external form of earth; or, combined with ſulphur, as ores; or, laſtly, in combination with acids, conſtituting metallic ſpars, &c. They occur in theſe various ſtates, either ſeparately or in combination with other metals.

§ CCCCLXXXVIII. They are remarkable for the property peculiar to themſelves of being dilated by repeated or continued preſſure. This property is termed ductility. But, as ductility is regulated by different laws, according to the nature of the preſſure applied, it became neceſſary to divide it into two kinds, viz. into malleability, when metals, under the hammer, or, by flatting mills, are formed into thin plates; and into tenacity, when drawn out into wire.

§ CCCCLXXXIX. As all metals are not ductile, the preſence or abſence of this property cauſed them to be divided into two claſſes, the limits of which are, however, very indefinite, Of the 18 metals with which we are acquainted, 8 are conſidered as ductile, or entire metals; and ten as brittle, or ſemimetals. If we conſider them according to their malleability, they appear in the following order: Gold, Silver, Platina, Copper, Iron, Tin, and Lead; but, according to their tenacity, thus: Platina, Gold, Iron, Copper, Silver, Tin, and Lead. To theſe we may add Mercury; but the degree of its malleability and tenacity is not yet accurately known. The ſemimetals are Zinc, Biſmuth, Nickel, Antimony, Cobalt, Manganeſe, Arſenic, Tungſten, Molybdena, and Uranite.

§ CCCCXC. All metals and ſemimetals, become fluid at a certain temperature. Mercury exiſts in that ſtate under the common temperature of the atmoſphere; but the reſt require a greater degree of heat; and ſome metals do not melt unleſs the heat be intenſe. Several fuſe before they become red hot, ſuch as Mercury, Lead, Tin, Biſmuth, Zinc. Some fuſe at a greater or leſs degree of ignition, as the remaining metals. The leaſt fuſible metals are Platina, Tungſten, Molybdena, and Uranite, which are fuſed only by the aid of oxygen gaz, or large burning lenſes.

§ CCCCXCI. All metals, when melted in earthen or glaſs veſſels, have a convex ſurface; and, if the maſſes be but ſmall, they form globules, which is owing to their great coheſion, and their inferior attraction to the veſſel. All fuſed metals, when ſlowly cooled, aſſume a determinate form, and cryſtallize in various ſhapes.

§ CCCCXCII. Metals become volatile by fuſion, and paſs off in a gazeous ſtate. Some undergo this change even by a moderate heat, as Mercury, Biſmuth, Antimony, Arſenic, &c. Moſt metals require, however, an intenſe heat for that purpoſe, for inſtance, Gold, Silver, and Platina.

§ CCCCXCIII. But of far greater importance is the change to which metals are liable, when fuſed in a higher or lower temperature in contact with oxygen gaz or atmoſpheric air. They are thus deprived of their coheſion, metallic ſplendour, and ductility, and aſſume the external appearance of earths. In this ſtate they are termed calces of metals, or metallic oxides.

§ CCCCXCIV. If a determinate quantity of Lead, Tin, or Mercury, be heated for ſome time in a pneumatic veſſel, carefully cloſed, containing oxygen gaz, we perceive that the oxygen gaz is conſiderably diminiſhed, and that the metal is either entirely, or in part, reduced to the ſtate of calx. During this change the weight of the metal increaſes, and this augmentation is preciſely equal to the weight of the oxygen gaz loſt.

§ CCCCXCV. If mercury, thus calcined or oxided, be diſtilled in a retort, adapted to the pneumatic apparatus, we ſhall obtain a conſiderable quantity of oxygen gaz, and the calx of mercury will reſume its metallic form. The loſs of weight, which the calx of mercury thus ſuſtains, is equal to the weight of the oxygen gaz obtained.

§ CCCCXCVI. But, if the calx of lead or tin be heated in a pneumatic veſſel filled with inflammable air, the air decreaſes, drops of water are formed, and the calx returns to its former metallic ſtate.

§ CCCCXCVII. From the experiments recited, and from a great number of others which we ſhall have occaſion to mention hereafter, it is evident, that during the calcination of metals, the metal ſimply combines with oxygen; and that oxides or calces of metals, in conſequence of the loſs of ſuch oxygen, regain their metallic ſplendour; this operation is termed reduction of metals. All metals, however, have not the ſame degree of affinity for oxygen; there are but few that part with it *per ſe*, by the mere increaſe of temperature; the greater number require the addition of a third body, which has a greater affinity for oxygen than the metal itſelf; for inſtance, nitrogen gaz, carbon, &c. in which caſe we obtain either carbonic acid or water. Metals, capable of being reduced *per ſe*, are termed noble. Theſe are gold, ſilver, platina, and mercury; others are termed baſe.

§ CCCCXCVIII. All metals may be likewiſe oxided by acids, but all acids do not act upon metals in general, nor in the ſame manner. But, during every combination of this kind, the acid is decompounded; its oxygen, combining with the metal, forms a metallic oxide, and its baſis, being diſengaged, remains either in the mixture, or is diſſipated in the ſtate of gaz. The metallic oxide, thus produced, is either immediately diſſolved in the remaining acid, and thus converted into a metallic ſalt, or is precipitated. In the former caſe, we ſay, that the acid has diſſolved the metal; in the latter, that it has only corroded it. In a few rare caſes, the metal is oxided merely by the oxygen of the water, mixed with the acid, and then diſſolved by the acid itſelf. Hydrogen gaz is, in this caſe, diſengaged.

§ CCCCXCIX. Metals can never, therefore, be combined with acids, unleſs they be previouſly oxided, and, conſequently, when diſſolved, they are always oxides. Yet moſt acids do not act upon metals but when in a metallic ſtate, and produce no effect upon thoſe which have been previouſly calcined by other means. The cauſe of this reſts probably either in the degree of oxidation, or upon its protraction.

§ D. When the union of a metallic oxide and an acid is diſſolved by a third body, which has a nearer affinity with the latter, the metallic oxide, in ſolution, falls to the bottom of the veſſel, and is termed a precipitate of the metal. But, if the decompoſition be effected by double affinity, ſo that the oxide of the metal is deprived of its oxygen, the metal is then precipitated in a metallic form. When the ſolvent is a neutral ſalt, the acid of ſuch ſalt combines with the metal, and produces a new metallic ſalt.

§ DI. Metals may be combined with each other in different proportions. The compounds thus ariſing are termed alloys, which are governed by the general laws of chemical compoſitions; nor do they poſſeſs the properties of their component metals, ſince they differ in ſpecific gravity, ductility, and chiefly in the degree of heat requiſite for their fuſion.

LXXII. OF GOLD.

§ DII. Gold is the moſt precious and leaſt changeable of all metals. Next to platina, it is the moſt ponderous of bodies, its ſpecific gravity, to that of water, being 19.2581 : 10000. It is alſo ſuperior to all other metals in malleability and tenacity, but inferior in hardneſs and elaſticity.

§ DIII. Gold is not liable to the leaſt alteration in atmoſpheric air. On expoſure to fire it becomes red hot, and aſſumes a greeniſh luſtre long before it melts, nor does it fuſe till it is heated to candeſcence: being then gradually cooled, it cryſtallizes in truncated tetraëdral pyramids. It reſiſts, in this ſtate, the ſtrongeſt heat that can be raiſed in a furnace; and it is only in the heat produced by large burning lenſes, or the flame excited by a ſtream of oxygen gaz, that it is rendered partly volatile, and vitrified. It is oxided and volatilized likewiſe by a very ſtrong electrical diſcharge.

§ DIV. Of the acids with which we are acquainted, there is none that has any action upon gold, except the oxygenated muriatic acid, which completely diſſolves it. This acid may be prepared for that purpoſe in the manner deſcribed, (§ CCXIII. & CCXVII.) or oxygenated by adding the nitric acid, when it is termed aqua regia. (§ CCXXV.) Common muriatic acid produces not the leaſt effect upon gold.

§ DV. During the ſolution of gold in aqua regia, nitrous gaz is diſengaged; the liquor aſſumes the colour of gold, is highly cauſtic, and tinges animal matter purple. If it be carefully evaporated, it depoſits ſmall golden cryſtals, which are muriate of gold. They attract moiſture from the atmoſphere, and become red when fuſed by a gentle heat.

§ DVI. Calcareous earth, magneſia, and the fixed alkalis, decompound the ſolution of gold, and precipitate it in the form of a yellow powder, which is a true oxide of gold, and which returns, on expoſure to fire, to its metallic ſtate, without the aid of any additional body. This oxide fuſes with all vitrifiable earths, and tinges them purple. It is now ſoluble likewiſe in acids, from which, however, it may be ſeparated again by heat or reſt.

§ DVII. If, in precipitating gold from its ſolution, a ſuperabundant portion of alkali be added, it again diſſolves the oxide of gold. But, if ammoniac be taken for that purpoſe, we obtain an oxide of gold of a deep yellow colour, which, after it has been ſlowly dried, becomes browniſh, and poſſeſſes the ſingular property of cauſing a conſiderable noiſe when reduced. On the application of a gentle heat, a ſimilar reduction takes place, provided the aqua regia, in which the gold is diſſolved, be prepared with the muriate of ammoniac, (§ CCXXVII.) and the gold be precipitated by the fixed alkalis. The precipitate, in either caſe, is termed fulminating gold.

§ DVIII. This fulminating gold is nearly one-fourth heavier than the gold employed for the ſolution. If fulminating gold be expoſed for ſome time to a gentle heat, ſo that no reduction take place, it will be entirely diveſted of its fulminating property; and if the operation be performed in cloſe veſſels, we ſhall obtain a ſmall portion of ammoniacal gaz; but, if we cauſe it to detonate in cloſe veſſels, the products are azotic gaz, drops of water, and gold in a metallic ſtate. The concentrated ſulphuric acid, fat oils, and ſulphuric ether, deprive gold of its fulminating property.

§ DIX. From the preceding experiments, and from the circumſtance that ammoniac is indiſpenſably requiſite for the production of fulminating gold, it is evident that this oxide of gold owes its fulminating property to that part of the ammoniac which adheres to it very ſtrongly, and which is decompounded by a ſlight increaſe of temperature, when its hydrogen inſtantly combines with the oxygen of the oxide of gold, whence the exploſion. The product, on this occaſion, is water; and both the gold and the azotic gaz are diſengaged in a very pure ſtate from the bodies with which they were combined.

§ DX. Tin precipitates gold from its ſolution in aqua regia, in the form of a purple oxide, but ſtill better if it be diſſolved in aqua regia. The precipitate obtained in this manner is termed the Purple Precipitate of Caſſius, the colour of which varies according as the ſolutions are more or leſs ſaturated, and according to the quantity of water with which they were previouſly diluted. In order that a beautiful purple precipitate may be produced, the ſolution of tin is prepared very ſlowly, and a conſiderable quantity of water is added to the ſolution of gold.

§ DXI. Neither pure ſulphur nor pure alkalis act upon gold, but ſulphuret of pot-aſh completely diſſolves it. For this purpoſe, equal parts of pot-aſh and ſulphur are haſtily melted with an eighth part of leaf gold, and then poured upon a ſtone table. This mixture, diſſolved in water, affords a ſolution of ſulphuret of gold of a yellowiſh green colour, from which the gold, together with the ſulphur, may be precipitated by acids. The former is ſeparated from the latter by heating it in open veſſels.

§ DXII. Volatile oils and ſulphuric ether do not act directly upon gold; but, being added to a ſolution of gold in aqua regia, the gold quits the aqua regia, and, by combining with the oil or ether, forms a diſtinct ſtratum, which floats upon the aqua regia, now colourleſs.

§ DXIII. Gold, for the various purpoſes to which it is applied, is more or leſs alloyed with other metals. The value of theſe compoſitions depends always upon the proportion of gold which they contain, and which is eſtimated by what are termed carats. A carat is the 1–24th part of the whole maſs. Thus a compoſition of 5–24th parts of gold, and 19th parts of copper, is ſaid to be gold, 5 carats fine.

LXXIII. OF PLATINA.

§ DXIV. Native platina has not hitherto been found in any country but South America, nor in any form but that of unconnected lamellæ. It is the moſt ponderous of all the material bodies with which we are acquainted; its ſpecific gravity, to that of water, being 22.0690. It is leſs malleable than gold, but more tenacious, and leſs deſtructible than all the other metals.

§ DXV. There is no metal which reſiſts the action of heat as much as platina; nor can it be fuſed but in the focus of a large burning lenſe, or by pure oxygen gaz; for, by the moſt intenſe heat that can be produced in a furnace, platina is merely welded. Like gold it is calcined and volatilized by a ſtrong electric ſpark.

§ DXVI. Platina, like gold, is not ſoluble in any acid, except the oxygenated muriatic acid, which diſſolves it completely, producing a diſengagement of nitrous gaz. This ſolution of platina is either red or yellow, and extremely cauſtic. It imparts a deep brown colour to animal matter.

§ DXVII. If this ſolution of platina be ſlowly evaporated in the open air, or otherwiſe, it yields ſmall brilliant cryſtals of a red colour, not eaſily ſoluble in water, and which are perfect muriate of platina. This neutral ſalt, if it be expoſed for a conſiderable time to an intenſe heat, is decompounded, its acid paſſes off, and a grey oxide of platina remains, which, after ſome time, parts likewiſe with its oxygen, and aſſumes a metallic form.

§ DXVIII. Muriate of platina is decompounded by pot-aſh, which precipitates the metal in the form of an orange-coloured powder. But this precipitate is not a pure oxide of platina, but a mixture of ſuch oxide and muriate of platina, not unfrequently united to the neutral ſalt then generated. The oxide of platina is freed from the latter by decoction in pure water; the reſidue is an aſh-coloured powder. But the precipitate, produced by pure ammoniac from the ſolution of platina, is very ſaline, and completely ſoluble in water, for nothing remains but particles of iron. Soda, quicklime, or lime-water, precipitate platina in the ſtate of pure oxide.

§ DXIX. Sal ammoniac is the only neutral ſalt by which platina is precipitated from its ſolution. The circumſtances attending this operation are not yet accurately known; but the orange-coloured precipitate which is obtained is extremely ſaline, and eaſily reduced to the metallic ſtate by heat. As muriate of ammoniac does not act upon a ſolution of gold in aqua regia, therefore platina, alloyed with gold, may be ſeparated from the latter by ſolution in aqua regia, and ſubſequent precipitation by muriate of ammoniac.

§ DXX. Since platina is never found in large maſſes, and as it is ſo difficult of fuſion, recourſe has been had to other methods to obtain it in larger maſſes. To this end we take platina, free from iron, and fuſe it with arſenic, or glaſs of phoſphorus. The latter is ſeparated by continued heat, and thus we obtain a concrete porous ſubſtance, which may be formed into a ſolid maſs under the hammer.

LXXIV. OF SILVER.

§ DXXI. Silver, next to gold, is the moſt malleable of all metals. Its ſpecific gravity to water is 10.5107. It ſuffers no change in the atmoſphere. On expoſure to fire it fuſes, after having acquired a white heat, and, when cooled, ſhoots into octaëdral cryſtals. If the degree of heat be intenſe, it volatilizes and becomes oxided, and is ultimately converted into glaſs of an olive-green colour.

§ DXXII. Silver is very rapidly diſſolved in pure nitric acid, and a conſiderable quantity of nitrous gaz is diſengaged. This ſolution, which is either ſomewhat green or colourleſs, according as the acid is more or leſs concentrated, deſtroys animal matter, and tinges it black. Two parts of nitric acid diſſolve one part of ſilver, and the concentrated ſolution depoſits white foliated brilliant cryſtals, known by the name of nitrate of ſilver. One hundred parts of nitric acid require 375 parts of ſilver for complete ſaturation, and, according to Leonhard, 100 parts of the cryſtals of nitrate of ſilver contain 64 parts ſilver, 22 acid, and 14 water.

§ DXXIII. Cryſtallized nitrate of ſilver remains dry in atmoſpheric air; but, on expoſure to light, it loſes its whiteneſs, and becomes black. Thrown upon burning coals it detonates, when the ſilver remains in the form of a white powder. Melted in a crucible, it ſwells up, and then fuſes. In this manner we obtain a black, porous, ſemi-cryſtallized maſs, known by the term *lapis infernalis*. This ſubſtance is beſt prepared, for medical purpoſes, when a ſolution of nitrate of ſilver, evaporated to dryneſs, is melted in a ſilver crucible, and afterwards poured into the uſual moulds. This nitrate of ſilver, it appears, is partly decompounded and changed into an oxide of ſilver; but, if kept too long in the fire, the whole maſs will be reduced to a metallic ſtate.

§ DXXIV. The nitric acid ſolution of ſilver is decompoſed by the fixed alkalis, which precipitate the ſilver in the form of a white oxide, reducible to its priſtine metallic ſtate by fuſion. Cauſtic ammoniac decompoſes it but ſlowly, and the precipitated oxide of ſilver appears of a grey colour. But we obtain an olive-green precipitate by means of lime-water. If this latter oxide be digeſted with pure ammoniac, it becomes black, and poſſeſſes the property of being reduced with detonation by the ſlighteſt friction. This ſubſtance is termed fulminating ſilver, the theory of which coincides with that of fulminating gold.

§ DXXV. Almoſt all metals and ſemi-metals decompoſe the ſolution of ſilver in the nitric acid, and precipitate this metal in a metallic ſtate. Hence, a plate of copper, being immerſed in a ſolution of this kind, is preſently covered with white glittering flakes, which are metallic ſilver, while the copper, on the contrary, is diſſolved in the nitric acid. When ſilver is precipitated from its ſolution by mercury, it inſtantly combines with the remainder of this metal, and thus produces very ſingular phenomena, which we ſhall conſider hereafter.

§ DXXVI. Although the muriatic acid may have a greater affinity for ſilver than the nitric acid, yet it does not act directly upon it when in the ſtate of metal, but diſſolves it with great facility when in the ſtate of oxide. Hence, if an oxide of ſilver, precipitated from its ſolution by pot-aſh, be digeſted with hot muriatic acid, a combination takes place, and muriate of ſilver is formed. But we obtain this ſalt in a much eaſier way, by adding pure muriatic acid to a nitric-acid ſolution of ſilver; for thus the ſilver combines with the muriatic acid, and produces a ſubſtance almoſt inſoluble in water, which falls to the bottom in the form of white flocculi. The ſame effect is produced by double decompoſition with all muriatic neutral ſalts; for, on adding the latter to a ſolution of ſilver, the ſilver combines with the muriatic acid, and the alkali with the nitric acid. This muriate of ſilver, in either caſe, is termed *luna cornea.* One hundred parts of muriatic acid combine with 420 parts of ſilver, and 100 parts of luna cornea contain 75 parts of ſilver, 18 of acid, and 7 parts of water.

§ DXXVII. Luna cornea is but ſlightly ſoluble in water, for one pound of water diſſolves no more than 4 or 5 grains of it. Expoſed to the atmoſphere and light, it is ſpeedily deprived of its whiteneſs, and becomes brown. It readily melts in the fire into a green tranſparent maſs, which may be cut with a knife like horn. At a more intenſe and laſting heat, it is partly decompoſed and partly volatilized.

§ DXXVIII. Luna cornea is decompounded by the fixed alkalis. Hence, if four parts of cauſtic or mild pot-aſh be well fuſed in a crucible with one part of luna cornea, the ſilver, after the crucible has been cooled, is found under a ſtratum of ſulphate of pot-aſh and the remaining alkali. The ſilver obtained by this proceſs is the pureſt that can be obtained by chemical means; and all ſilver, intended for nice purpoſes, ought to be thus purified.

§ DXXIX. Luna cornea is likewiſe decompounded by ſeveral other metals, as lead, tin, iron, &c. If three parts of any of theſe metals be fuſed with one part of luna cornea, the muriatic acid combines with the metal, and the ſilver is reduced, but always alloyed with part of the metal employed.

§ DXXX. The ſulphuric acid has no action upon pure ſilver, except when concentrated; and it is requiſite, moreover, to facilitate the ſolution by increaſing the temperature of the acid to ebullition. The ſilver, during the diſengagement of ſulphureous acid gaz, is thus changed into a white powder, which is diſſolved on the addition of another portion of ſulphuric acid. We obtain a ſimilar ſolution if an oxide of ſilver, precipitated from nitrate of ſilver by alkalis, be digeſted with ſulphuric acid, and the white powder above-mentioned is alſo formed by the decompoſition of nitrate of ſilver, by means of the ſulphuric acid, or neutral ſulphates.

§ DXXXI. Silver combines very readily with ſulphur, and if thin plates of ſilver, ſtratified with ſulphur, be melted in a crucible, we ſhall obtain a blueiſh black and brittle ſubſtance, which is the ſulphuret of ſilver. But, by protracted fuſion, this ſubſtance is again decompounded, the ſulphur deflagrates, and pure ſilver remains. Sulphuret of potaſh alſo diſſolves ſilver, which may afterwards be ſeparated in the ſtate of ſulphuret, by acids.

§ DXXXII. One hundred parts of ſulphuric acid, according to Kirwan, diſſolve 390 parts of ſilver; which ſolution ſhoots into ſmall acicular cryſtals, eaſily fuſible in fire, and decompoundable by all the alkalis, and by iron, copper, zinc, and other metals.

§ DXXXIII. The ſilver uſed for plate and coin is generally alloyed with copper,* and the value of the compoſition is eſtimated by the quantity of ſilver which it contains. For this purpoſe, the maſs is divided into 12 parts, called pennyweights, each pennyweight being ſubdivided into 24 grains. Thus an alloy of 10 pennyweights and 12 grains of ſilver, and one pennyweight 12 grains of copper, is ſaid to be ſilver 10 pennyweights 12 grains fine.

LXXV. OF MERCURY.

§ DXXXIV. Mercury is diſtinguiſhed from all other metals and ſemimetals on account of the low temperature at which it appears in a fluid ſtate, for the ordinary heat of the atmoſphere is ſufficient to maintain it in a ſtate of fluidity, and it becomes ſolid only at the temperature of from 32 to 45° below 0. of Reamur's thermometer. The ſpecific gravity of this metal is 13. 5681. Its malleability and tenacity, when ſolid; has not hitherto been determined.

§ DXXXV. It ſuffers no change either in atmoſpheric air or water as long as it remains in a ſtate of reſt. But, by ſtrong and continued agitation, a ſmall part of it is converted into a blackiſh powder, termed Æthiop's per ſe. On expoſure to fire it is heated very uniformly; it then boils with rapidity, and riſes in white fumes, which, being condenſed on the approach of colder bodies, again exhibit the metallic mercury. When heated in contact with atmoſpheric air, it is converted into a brilliant ſcaly red powder, termed calcined mercury, or precipitated per ſe. To obtain it in greater quantity, mercury is put into a phial with a flat bottom and a long narrow neck, and expoſed for ſome months to an uninterrupted heat on the ſand-bath, nearly equal to that which produces ebullition of the mercury. Such parts of the metallic mercury as remain are then ſeparated from the precipitate by preſſure through leather.

---

* The Britiſh coinage is 11 ounces 2 pennyweights fine. T.

§ DXXXVI. If this precipitate be heated in contact with atmoſpheric air, it partly ſublimes in beautiful red cryſtals, or melts into a red glaſs. Diſtilled in cloſed veſſels, it affords a conſiderable quantity of oxygen gaz, and is changed into metallic mercury. As oxygen gaz is abſolutely neceſſary to the formation of this precipitate, and as the loſs of it cauſes the mercury to be reduced, it is evident, that this precipitate is a true oxide of mercury.

§ DXXXVII. The ſulphuric acid does not act upon mercury, unleſs it be highly concentrated. To effect this combination, two or three parts of concentrated ſulphuric acid are poured upon one part of mercury, and then heated; a ſtrong efferveſcence takes place, and a very conſiderable quantity of ſulphureous acid gaz is developed. If, in this manner, the mixture be diſtilled to dryneſs, the retort is found to contain a white ſaline maſs, which conſiſts chiefly of oxide of mercury and a ſmall portion of ſulphuric acid. This ſubſtance weighs one third more than the mercury made uſe of, and attracts humidity from the atmoſphere. It is termed ſulphate of mercury.

§ DXXXVIII. If this ſulphate of mercury be waſhed in cold water, a white powder, which is a pure oxide of mercury, remains; but, if boiling water be uſed for that purpoſe, the powder becomes yellow, and is then termed turbith mineral. By evaporating the water, we obtain ſmall acicular cryſtals, which, by pouring hot water on them, are alſo changed into turbith mineral.

§ DXXXIX. Sulphate of mercury, if ſuperſaturated with acid, is not precipitated by water. But in both caſes it is decompounded by alkalis and alkaline earths, which precipitate the mercury in the ſtate of a yellow oxide, reducible by fire alone.

§ DXL. The nitric acid acts upon mercury with great facility; but the phenomena, which accompany this ſolution, differ according as the acid is more or leſs concentrated, and according to the application or non-application of artificial heat. If nitric acid of a moderate ſtrength be affuſed upon mercury without heat, the ſolution proceeds very ſlowly, and without any conſiderable quantity of red vapours. The liquid, thus obtained, is not changed on affuſing pure water upon it, and, when ſuffered to reſt, affords flat tetraëdral cryſtals, but, if evaporated, ſtriated priſms.

§ DXLI. If the ſolution of mercury in the nitric acid be aſſiſted by heat, a much greater quantity of nitrous gaz is diſengaged, and, on the addition of pure water, nearly the whole of the mercury is precipitated in the form of a white powder, or, if boiling water be uſed, as a yellow powder. This ſolution, when evaporated, yields a white ſemi-cryſtallized maſs.

§ DXLII. The cauſe of thoſe ſolutions differing from each other is probably this; that the ſolution, formed by the aid of heat, contains a much greater quantity of oxide of mercury than that which is prepared in the cold; and that, on the addition of water, the acid is unable to maintain the whole of the oxide in ſolution, whence it is precipitated: for the precipitate, acquired in this manner, is a mere oxide of mercury, and the remaining liquor ſtill contains nitrate of mercury. A ſolution of mercury prepared in the cold, after being ſtrongly heated, is alſo decompounded by water, becauſe a part of the nitric acid is decompounded, and, conſequently, the proportion of the oxide of mercury to the acid is increaſed. Finally, if a freſh quantity of nitric acid be added to the ſolutions above-mentioned, the precipitate is again diſſolved.

§ DXLIII. This ſolution, as well as cryſtallized nitrate of mercury, is extremely cauſtic, and tinges the ſkin yellow. The ſalt aſſumes the ſame colour, if dry, and expoſed to the atmoſphere. It detonates upon burning coals. When heated in cloſed veſſels it becomes yellow, and ultimately red, when it is termed red precipitate of mercury. During this operation, the moſt conſiderable part of the nitric acid is decompounded, and comes over in the ſtate of oxygen and nitrogen gazes. The red precipitate is, therefore, an oxide of mercury, ſtill combined with a ſmall portion of nitric acid. It is ſublimed and reduced to metallic mercury when heated more ſtrongly and for a greater length of time.

DXLIV. Nitrate of mercury is decompoſed by alkalis, calcareous earth, baryt, and magneſia, which precipitate a mercurial oxide of a colour more or leſs approaching to green or brown, reducible by heat alone. If half a dram of this oxide be triturated with ſix grains of flowers of ſulphur and expoſed to the fire in an iron ladle, the mixture explodes with a loud noiſe, and a blueiſh powder, which is ſulphuret of mercury, remains.

DXLV. Common muriatic acid produces no effect upon mercury when in the ſtate of metal, but it acts very powerfully upon it when reduced to an oxide; therefore, whenever muriatic acid and oxide of mercury come either directly or indirectly into contact, they combine and form a ſalt which is perfectly inſoluble in water. Hence, if muriatic acid, or a ſolution of muriatic ſalts, be added by drops to a nitric acid ſolution of mercury, a decompoſition takes place, and the muriatic acid, combined with the mercury, falls to the bottom of the veſſel in the ſtate of a white powder, termed white precipitate of mercury, or mercurius coſmeticus.

§ DXLVI. But the caſe is very different with the oxygenated muriatic acid, which, by combining with the mercury, forms a neutral ſalt, highly ſoluble in water, and, conſequently, no precipitate is produced. This compound of mercury and the oxygenated muriatic acid is termed, from the uſual mode of preparing it, corroſive ſublimate, and is beſt obtained by the following proceſſes.

§ DXLVII. Equal parts of red precipitate, calcined ſulphate of iron, and decrepitated common ſalt, being well mixed by trituration in a glaſs mortar, are introduced into a glaſs cucurbit, and ſublimation is begun on a ſand-bath; at firſt, a ſmall quantity of nitrous gaz is diſengaged, a cloud of white fumes ſucceeds, which, being condenſed by the ſides of the veſſel, conſtitute the corroſive ſublimate. At the bottom of the cucurbit remains a brick-coloured maſs. The vitriolic acid firſt decompoſes the common ſalt and expels its acid, which immediately acts upon the nitrate of mercury, diſengaging from it not only the nitric acid, but depriving it of part of its oxygen, whence it becomes oxygenated. The nitric acid, therefore, paſſes off in the ſtate of nitrous gaz; the oxygenated muriatic acid combines with the mercury and is ſublimed, and ſulphate of ſoda, a ſubſtance produced by the ſulphuric acid and the ſoda of the culinary ſalt, beſide oxide of iron, remains.

§ DXLVIII. Or four parts of ſulphate of mercury are triturated with five parts of decrepitated culinary ſalt, and ſublimed as before. In this proceſs the common ſalt is directly decompounded by the ſulphuric acid, and the muriatic acid which is expelled combines with the mercury, already in the ſtate of oxide. Laſtly, ſublimate of mercury is formed by the decompoſition of nitrate of mercury by the oxygenated muriatic acid; for, on evaporating the ſolution, the ſublimate ſhoots into cryſtals.

§ DXLIX. Corroſive ſublimate of mercury has an extremely poignant, ungrateful, and metallic taſte, diſcernible even when diluted with a conſiderable quantity of water. The atmoſphere has no effect upon it. If it be ſlowly heated, the whole is ſublimed, and, on the approach of colder bodies, aſſumes a regular cryſtalline form. Its cryſtals, in that caſe, repreſent very flat priſms. A ſtrong heat changes it to a ſemi-vitrified maſs. It is completely diſſolved in ſixteen parts of cold water, or in two parts of boiling water, and, on evaporating this ſolution, it ſhoots into flat priſmatic cryſtals. It is ſoluble, likewiſe, in ſpirit of wine.

§ DL. Corroſive ſublimate is decompounded by the fixed alkalis, which precipitate the mercury in the form of a yellow oxide. Ammoniac precipitates a white, and lime-water a yellow oxide. This latter mixture is termed phagedenic water.

DLI. If equal parts of metallic mercury and of corroſive ſublimate be triturated in a glaſs mortar, they combine, and form a grey powder. If this mixture be then ſublimed in a cucurbit, we find, after the operation is finiſhed, that the neck contains a ſmall portion of ſublimate, and the belly, which reſts upon the ſand-bath, a more ſolid, white, and cryſtalline maſs, termed mercurius dulcis.

§ DLII. Mercurius dulcis, when very ſlowly ſublimed, ſhoots into priſmatic tetraëdral cryſtals, with tetraëdral extremities. This ſublimate is perfectly inſipid, and almoſt inſoluble in water. After it has repeatedly undergone the proceſs of ſublimation, it is termed calomel. During theſe operations, a ſmall portion of metallic mercury is always ſeparated and, of courſe, a proportionate quantityof corroſive ſublimate is obtained.

§ DLIII. The mercury, which is added to the corroſive ſublimate, becomes an oxide, by combining with the ſuperabundant portion of oxygen of the oxygenated muriatic acid, which thus becomes common muriatic acid; with which the oxide of mercury unites. This combination is rendered more intimate by ſubſequent ſublimation; and mercurius dulcis conſiſts therefore of common muriatic acid and a greater portion of oxide of mercury. Hence, it is obvious, that the white precipitate of mercury approaches very nearly to mercurius dulcis, and accordingly we find, that the former may be changed into the latter by ſublimation alone.

§ DLIV. Mercurius dulcis is partly reduced and partly decompounded by repeated ſublimation, and the reſidue is ultimately corroſive ſublimate. The whole of the mercurius dulcis may be thus changed into corroſive ſublimate. The common method of pre-preparing calomel is, therefore, abſurd. But to be certain that the mercurius dulcis is not mixed with corroſive ſublimate, it is proper to waſh it in tepid water. If the mercurius dulcis become grey, and not yellow, when triturated with lime-water, and if it then change the colour of gold coin white, it is a ſign that it has been properly prepared.

§ DLV. Corroſive ſublimate is decompounded by different metals, ſuch as arſenic, copper, antimony, tin, &c. If an amalgam of mercury and tin be triturated with an equal portion of corroſive ſublimate, and ſlowly diſtilled in a retort, we ſhall obtain a brown liquor, which, in contact with atmoſpheric air, emits white fumes for a conſiderable time. This is termed fuming ſpirit of Libavius. If the diſtillation be protracted, an inſpiſſated liquor ſucceeds, which becomes ſolid when cooled, and is termed butter of tin.

§ DLVI. During this proceſs, the oxygenated muriatic acid quits the mercury, and combines with the tin, forming the fuming ſpirit of Libavius, which is, therefore, a true oxygenated muriate of tin. The combination of this oxy-muriate with water is attended with efferveſcence and a diſengagement of nitrogen gaz. It forms, if mixed with water in the proportion of 7 to 22, a ſolid maſs, which is very ſimilar to butter of tin, viz. common muriate of tin. Fuming ſpirit of Libavius may alſo be converted into ſuch common muriate of tin by direct combination with a new portion of tin.

§ DLVII. Mercury combines very readily with ſulphur, and, if triturated with it for ſome time in a glaſs mortar, it diſappears, and we obtain a black powder, termed Æthiop's mineral prepared without fire. The combination of theſe two bodies is effected ſtill quicker if ſeven parts of mercury be gradually affuſed upon one part of ſulphur, melted in an unglazed earthen veſſel. In a very ſhort time the maſs becomes black and inſpiſſated; we ought then to beware of the noxious vapours by covering the veſſel till it is cooled. The ſubſtance, thus obtained, is Æthiop's mineral prepared by fire.

§ DLVIII. This latter Æthiops differs from the former in as much as it contains a greater quantity of mercury, and as the combination is more intimate. By ſubliming it in a cucurbit, we obtain artificial cinnabar, which, when levigated with water upon a ſtone table, appears of a deep ſcarlet.

§ DLIX. Cinnabar is decompounded not only by alkalis and lime, but alſo by different metals, which combine with the ſulphur, and expel the mercury in a very pure metallic ſtate. Quicklime and iron produce this effect in an eminent degree.

§ DLX. Mercury combines alſo with moſt of the other metals, with which it forms half-ſolid maſſes, termed amalgams; the proceſs itſelf is termed amalgamation. Some metals combine very readily with it, and without the aid of any conſiderable portion of heat; ſuch as gold, ſilver, lead, &c. others, on the contrary, combine more difficultly with mercury; as platina, iron, copper, &c. and cobalt and antimony do not combine with it at all.

§ DLXI. Moſt of theſe amalgams, when melted and cooled, aſſume a regular cryſtallized form; and metals, combined with mercury, may be obtained in a cryſtalline ſtate, if the mercury be gradually expelled from them by heat.

§ DLXII. The cryſtallization of amalgam of ſilver, if effected in a particular way, produces a beautiful phenomenon, commonly termed arbor Dianæ. The beſt method is to mix ſix drams of the ſolution of nitrate of ſilver with four drams of the ſolution of nitrate of mercury. Theſe are to be diluted with five ounces of diſtilled water, and poured into a glaſs veſſel of the form of an inverted cone, containing ſix drams of an amalgam of ſeven parts of mercury and one part of ſilver. By this means, the ſolution of ſilver is ſlowly decompounded by the mercury of the amalgam; and the ſilver, which is precipitated in a metallic form, is attracted by the remaining amalgam, and thus produces that beautiful arboreſcence which is the object of this proceſs.

§ DLXIII. Mercury combines very readily with tin, eſpecially if the latter be previouſly fuſed. This amalgam is uſed for covering the back ſurface of looking-glaſſes, and combined with zinc, for coating the cuſhions of electrical machines.

LXXVI. OF COPPER.

§ DLXIV. Copper, or Venus of the Alchemiſts, is a very hard, elaſtic, malleable, tenacious metal, of a granular fracture. Its ſpecific gravity is 8.8785-1.0000. It loſes its metallic ſplendour on expoſure to the atmoſphere, and becomes inveſted with a green ochre, eſpecially if the air be moiſt. But this ochre only covers the ſurface of the metal, and even prevents its further deſtruction.

§ DLXV. On expoſure to fire it melts after becoming white, and volatilizes with a green flame. During cooling, it aſſumes the form of octaëdral cryſtals. Heated in contact with atmoſpheric air, its ſurface becomes an oxide, which may be ſeparated from the remaining maſs in the form of ſcales of a blackiſh red colour, by ſtriking it with a hammer, eſpecially if the copper, when removed from the fire, be plunged into cold water.

§ DLXVI. The ſulphuric acid does not act upon copper except when in a concentrated ſtate, and at the temperature of ebullition. We obtain, in that caſe, a dry white ſubſtance, conſiſting of oxide and ſulphate of copper, which by lixiviation in water, filtration, and evaporation, affords oblong rhomboidal cryſtals, of a beautiful blue colour, termed blue vitriol, or ſulphate of copper. One hundred parts of ſulphuric acid diſſolve 260 parts of copper; and 100 parts of cryſtallized ſulphate of copper contain 27 parts of copper, 30 parts of acid, and 43 parts of water of cryſtallization.

§ DLXVII. Sulphate of copper has a ſtiptic diſagreeable taſte. It readily diſſolves in three parts of boiling water. Atmoſpheric air changes it into a white powder. On expoſure to fire, it melts with great facility; but, if the heat be increaſed, it is decompounded, the acid eſcapes, and the copper remains in the ſtate of oxide.

§ DLXVIII. The fixed alkalis, as well as the alkaline earths, decompoſe the blue vitriol, and precipitate its copper in the ſtate of a blueiſh oxide; but which, when dried, becomes green. Mild alkalis precipitate the copper without efferveſcence, on which occaſion the carbonic acid ſeems to unite with the oxide of copper. Iron, however, precipitates it in the form of metal.

§ DLXIX. The nitric acid diſſolves copper with great violence, and diſengages at the ſame time a conſiderable quantity of nitrous gaz, but a ſmall portion of brown oxide of copper is always ſeparated during this proceſs. The ſolution is extremely cauſtic; its colour is dark blue; by careful evaporation it yields hexaëdral priſmatic or rhomboidal cryſtals, ſoluble in ſpirit of wine, and decompoundable by fire alone, when the copper remains in the ſtate of a brown oxide. Theſe cryſtals are likewiſe decompounded by alkalis, alkaline earths, iron, and zinc. The former precipitate a blue oxide, but the two latter metallic copper.

§ DLXX. The muriatic acid acts upon copper and its oxide only when concentrated and aſſiſted by heat, though more readily upon the latter. The ſolution appears of a beautiful green colour, and depoſits, when cooled, very beautiful priſmatic cryſtals, of a very aſtringent acrid taſte, ſoluble in ſpirit of wine, and fuſible in a moderate heat, but which do not part with their acid unleſs the heat be intenſe. This muriate of copper is decompounded by the ſame bodies which decompoſe ſulphate and nitrate of copper.

§ DLXXI. The fixed alkalis act but very ſlightly upon copper; if a ſolution of cauſtic pot-aſh, or ſoda, be digeſted upon copper filings, it becomes ſomewhat blue, and the copper is covered at the ſame time with a powder which is alſo blue. It is ſaid that thoſe alkalis act more powerfully upon copper in the cold than when the temperature is increaſed, and that the preſence of atmoſpheric air is abſolutely neceſſary.

§ DLXXII. Copper is very readily diſſolved by cauſtic ammoniac, but only in ſmall quantity. The ſolution appears of a moſt beautiful dark blue. But this colour diſappears if the ſolution be kept for ſome time in a cloſed veſſel, but returns on expoſure to the atmoſphere. The ſolution affords by ſlow evaporation brilliant blue cryſtals, which, as well as the ſolution, are decompounded by fire; in which caſe the ammoniac eſcapes, and the copper remains in the ſtate of a green oxide. Pure ammoniac acts as powerfully upon oxide of copper as upon copper itſelf; and as even the ſmalleſt quantity of copper communicates to the ammoniac a beautiful blue colour, we make uſe of this alkali to detect the preſence of copper in various mixtures.

§ DLXXIII. Copper combines very readily with ſulphur, eſpecially in the dry way, if a mixture of copper filings and flowers of ſulphur, or copper ſpangles and ſulphur, diſpoſed in ſtrata, be melted in a crucible. We obtain, in either caſe, a blackiſh, brittle, and very fuſible maſs, termed ſulphuret of copper. This ſubſtance is decompounded by roaſting; the ſulphur is diſſipated, and a brown oxide of copper, termed burnt copper, remains. But, if this operation be made by a gentle heat only, and in contact with atmoſpheric air, the ſulphur will combine with the oxygen of the atmoſphere, and form ſulphuric acid; which, with the oxide of copper, forms ſulphate of copper.

§ DLXXIV. Hepar of ſulphur combines with copper both in the moiſt and dry way. Hence, if two parts of hepar of ſulphur be melted in a crucible with one part of copper filings, we obtain a liver-coloured maſs, which is perfectly ſoluble in water; and from which acids precipitate both the copper and the ſulphur.

LXXVII. OF IRON.

§ DLXXV. Iron, (Mars,) is diſtinguiſhed from all the other metals by its property of being attracted by the magnet, and of becoming magnetic itſelf. This metal is very hard and tenacious. Its ſpecific gravity is between 7.2070. and 7.8163. Its malleability is not conſiderable, for it becomes brittle by hammering. Moreover, it is the only metal which has its particles detached and fuſed when ſtruck with flint or hard ſtones. Laſtly, with manganeſe it forms a conſtituent part of all animal and vegetables bodies.

§ DLXXVI. Pure iron requires a moſt intenſe heat for fuſion; but very fine iron filings, thrown into flame, fuſe, and burn with luſtre. The ſame effect is produced if greater maſſes of iron be expoſed to the action of large burning lenſes, or to a ſtream of oxygen gaz, when they melt and burn with a blue flame, are half oxided, and become black and brittle. Iron, on expoſure to the fire, is oxided before it melts; and, if kept red hot for ſome time, its ſurface is covered with black ſcales, or ſcoriæ, which may be ſeparated on ſtriking it with a hammer. If theſe ſcoriæ, or freſh iron filings, be heated for ſome time under a muffle, they will be changed into a brown powder, which is not obedient to the loadſtone, termed aſtringent crocus Martis.

§ DLXXVII. Larger maſſes of melted iron, when ſlowly cooled, ſhoot into octaëdral cryſtals. It admits of a ſimilar but leſs perfect cryſtallization, if, when ſtrongly heated, it be inſtantly plunged into water, or other liquids, and thus ſuddenly cooled. The reaſon is, that the particles of the iron, removed from each other by the heat, have not, on account of their ſudden refrigeration, ſufficient time to contract, and fall into the ſame order in which they exiſted before, whence the iron becomes hard and brittle. This operation is called tempering. Steel is fitteſt for this purpoſe.

§ DLXXVIII. Iron, on expoſure to the atmoſphere, eſpecially if moiſt, loſes its metallic luſtre, and its ſurface becomes inveſted with a brown yellow cruſt, called ruſt. This calcination of iron extends, by degrees, through the whole maſs, and much quicker in places where the air is corrupted, than where it is pure. Thus iron filings, by ſprinkling water upon them, and expoſing them to the atmoſphere, are at length converted entirely into ruſt; which, when levigated, was formerly termed Aperient crocus martis. Ruſt, diſtilled in cloſe veſſels, affords a conſiderable quantity of carbonic acid gaz, and a black oxide of iron remains. Ruſt is not therefore merely an oxide of iron, but partly a true ſalt, formed by the carbonic acid and iron.

§ DLXXIX. Water, at the common temperature of the atmoſphere, acts upon iron with conſiderable power. If it be poured into a veſſel containing pure iron filings, and agitated from time to time, the filings will be converted into a delicate powder, termed martial æthiops. During this change of the iron, hydrogen gaz is developed; and the æthiops obtained is found to be one-fourth heavier than the filings made uſe of. Hence, it appears, that the water is partly decompounded during the above operation, that its oxygen unites with the iron, rendering it a ſemi-oxided maſs, which is ſtill obedient to the loadſtone, and that the other conſtituent of the water eſcapes in the form of inflammable air, or hydrogen gaz. Martial æthiops is ſoon changed into perfect calx, when expoſed to the atmoſphere, and ought therefore to be kept in veſſels carefully cloſed. This black æthiops is obtained ſtill more readily in the manner deſcribed (§ DLXXVIII.) or by conducting the vapours of water over red hot iron, (§ CXIX.)

§ DLXXX. The concentrated ſulphuric acid acts upon iron only at the temperature of ebullition, in which caſe we obſerve either a diſengagement of ſulphureous acid, or a ſeparation of the ſulphur itſelf. But, if the acid be diluted with water, it diſſolves the iron with great violence, and a conſiderable quantity of hydrogen gaz is formed. As, in the latter caſe, the ſulphuric acid combined with the iron requires preciſely the ſame quantity of alkali for ſaturation which it would have required before the combination took place; and as in the former caſe the ſolution of the iron is attended with difficulty and a ſeparation of the ſulphur itſelf, we have a right to conclude, that in the latter caſe the iron is oxided by the water of the mixture alone, and that it is then only, and not before, diſſolved in the ſulphuric acid.

§ DLXXXI. One hundred parts of ſulphuric acid require 270 parts of iron for complete ſaturation; and the ſolution, when evaporated, ſhoots into green, tranſparent, rhomboidal cryſtals, termed artificial vitriol, or ſulphate of iron, 100 parts of which, according to Rinmann, contain 25 parts of iron, 20 parts of acid, and 55 parts of water of cryſtallization. Sulphate of iron has an aſtringent taſte. It is decompounded in the air, for the oxide of iron, attracting a new portion of oxygen from the atmoſphere, can remain no longer in combination with the ſulphuric acid, and is therefore ſeparated in the ſtate of crocus Martis. The ſame phenomenon is obſerved on diſſolving it; for the ſurface of the ſolution is gradually covered with a yellow pellicle, which reflects various colours.

§ DLXXXII. Sulphate of iron melts on expoſure to the fire, and, after loſing its water of cryſtallization, becomes a white powder, which, calcined ſome time longer, is partly deprived of its acid, and aſſumes a red colour. This red ſulphate of iron attracts the humidity of the air with great eagerneſs, and, if it be diſtilled in a ſtrong fire, it parts with all its acid, nothing remaining in the retort but a red oxide of iron.

§ DLXXXIII. Sulphate of iron is perfectly diſſolved in ſix parts of cold, or in two parts of boiling water, when ſome of the oxide of iron is always ſeparated. After the greateſt part of the ſulphate of iron is cryſtallized, there remains, even if the ſolution be previouſly filtrated, a brown incryſtallizable mother-water, which ſeems to contain the iron in a more oxided ſtate, and which when evaporated to dryneſs affords a yellowiſh green powder. The iron is alſo precipitated from this mother-water by alumin, copper, and even by metallic iron, which cannot be done with pure ſulphate of iron.

§ DLXXXIV. Sulphate of iron is decompounded by quicklime and alkalis. Lime-water and the cauſtic fixed alkalis precipitate the iron in flakes of a greeniſh hue; which being carefully dried in cloſe veſſels, conſtitute a black powder, attractive by the loadſtone. But if thoſe precipitants be added to exceſs, the precipitate is again diſſolved, and gives to the ſolution a red colour. Ærated fixed alkalis precipitate the iron in the ſtate of a greeniſh oxide, which is not diſſolved by them when ſuperſaturated. Pure ammoniac precipitates a blackiſh green oxide of iron, which is obedient to the loadſtone, but not diſſolved on the addition of another portion of ammoniac; but the greyiſh green oxide of iron, precipitated by mild ammoniac, is partly diſſolved, if the ammoniac be uſed to exceſs.

§ DLXXXV. Iron is very readily diſſolved in the nitric acid, when a conſiderable quantity of nitrous gaz is diſengaged. If the nitric acid be concentrated, and iron filings made uſe of, we ſhall obtain a brown red ſolution, which is gradually decompounded when brought into contact with the atmoſphere, the iron being depoſited in the form of a yellow oxide. This ſolution is likewiſe decompoſed on the addition of new iron, becauſe the iron is diſſolved in the nitric acid, and the oxide, contained in the ſolution, is precipitated. In order, therefore, to obtain a more permanent ſolution of iron in the nitric acid, the acid ought to be much diluted with water, and the iron ſhould be taken in larger maſſes. In this caſe we obtain a ſolution of a pale green colour, which, like the former ſolution, is decompounded by evaporation, and changed into a gelatinous maſs.

§ DLXXXVI. Both mild and cauſtic alkalis precipitate the iron from its ſolution in nitric acid.—The pure alkalis precipitate it in the ſtate of a brown oxide, which, on the addition of more alkali, is diſſolved only in a ſlight degree. But the mild alkalis precipitate a yellow red oxide, which is completely diſſolved in an additional portion of the alkali. The liquor thus formed, conſiſting of regenerated nitre, oxide of iron, and mild alkali, has a browniſh red colour, and is known by the name of Staal's alkaline tincture of iron.

§ DLXXXVII. This alkaline tincture of iron is gradually deprived of its colour, and parts with its oxide. It is decompounded by acids, and the nitric acid precipitates a brick-coloured oxide, which is ſoluble in acids. Pure and mild ammoniac precipitate the iron from its ſolution in nitric acid as a dark green oxide, which is again diſſolved in the latter of thoſe alkalis. The alkaline tincture of iron, thus obtained, is very red.

§ DLXXXVIII. Iron is ſpeedily diſſolved in muriatic acid diluted with water; and, on this occaſion, a copious quantity of hydrogen gaz is developed. As the muriatic acid, ſubſequent to its combination with the iron, requires preciſely the ſame quantity of alkali for ſaturation as before, we have reaſon to conclude, that the iron alſo, in this caſe, is oxided ſolely by the water of the mixture, and that it is then only, and not before, taken up by the acid. This ſolution has a greeniſh yellow colour, and is eaſily preſerved in bottles carefully cloſed; but, on expoſure to the atmoſphere, the greater part of the iron is depoſited in the ſtate of a yellow powder, the colour of which is darker the longer the ſolution has been in contact with the atmoſphere.

this
least
[illegible]

§ DLXXXIX. Muriate of iron does not admit of a regular cryſtallization; for, by evaporating the ſolution, we obtain a ſemi-cryſtallized maſs, which deliqueſces in the atmoſphere, and is then termed oil of iron. This maſs, however, melts by a gentle heat; but, if the heat be increaſed, it is partly decompounded; the acid, combined with a ſmall quantity of iron, comes over, and the remaining iron is left in the ſtate of a yellowiſh brown oxide. Alkalis and lime, in like manner, decompoſe this ſolution, but the oxide which is precipitated is leſs changed, and may be eaſily reduced to martial æthiops, or a black ſemi-oxide of iron.

§ DXC. Sal ammoniac is decompounded by iron, eſpecially when in the ſtate of oxide. Hence, if equal parts of bloodſtone and ſal ammoniac be ſublimed in a cucurbit with an alembic, we obtain, at firſt, a ſmall portion of volatile alkali, and afterwards ſal ammoniac variouſly tinged by the oxide of iron, termed flowers of martial ſal ammoniac. In the retort there remains a ſmall portion of ſal ammoniac, mixed with muriate of iron, on which account it deliqueſces in the air.

§ DXCI. Carbonic acid and iron combine very well; and if water, impregnated with this acid, be poured upon iron filings, it will receive an aſtringent and pungent taſte. When we expoſe this ſolution to the atmoſphere, its ſurface will be covered with a pellicle, which reflects various colours, and the ſolution is at the ſame time decompounded, and depoſits a brown oxide of iron. The ſame effect is produced by heat. The mild alkalis have no action upon it; but cauſtic alkalis decompoſe it, and precipitate the iron in the form of a brown oxide.—This ſolution is met with in mineral chalybeate waters.

§ DXCII. Sulphur acts upon iron at the common temperature of the atmoſphere; for, if water be ſprinkled upon iron filings and ſulphur, the mixture becomes heated after ſome time, and emits aqueous vapours and hydrogen gaz, and ultimately inflames, if the maſſes be great. Sulphur and iron combine very readily in the fire, and form a yellow and very fuſible ſubſtance, termed artificial pyrites, or ſulphuret of iron.

§ DXCIII. Iron and carbon combine with great facility in the dry way; and the compoſition which is thus formed poſſeſſes very ſingular properties, greatly different from thoſe of iron. Theſe bodies may be combined in different proportions: a conſiderable quantity of pure iron, united to a ſmall portion of carbon, forms ſteel. The method of preparing it conſiſts in putting bars of iron into veſſels filled with powdered carbon, or ſuch bodies as contain carbon in abundance, and afterwards expoſing them to an intenſe heat; by which means the iron is not only purified, and more perfectly reduced, but it alſo abſorbs a part of the carbon. Steel principally differs from iron in its greater fuſibility, and its capacity of becoming much harder.

§ DXCIV. But if iron be combined with a ſtill greater portion of carbon, it forms that peculiar body which is known by the name of plumbago, or black lead.—We have not hitherto been able to produce a perfect ſpecimen of this ſubſtance by art; but nature contains it in conſiderable abundance. It ſuffers no change, either in water or atmoſpheric air, nor when expoſed to fire in cloſe veſſels, but burns ſlowly if it be heated in contact with air, and nothing remains but a ſmall portion of oxide of iron. It is decompounded by treating it in the dry way with the cauſtic fixed alkalis, which remain in a mild ſtate. During this proceſs, the carbon is burnt in conſequence of the decompoſition of the water contained in the ſalts; for hydrogen gaz is diſengaged, the carbonic acid which is generated combines with the alkali, and the pure iron remains in the ſtate of oxide. Acids produce no effect upon plumbago. With nitre it detonates like pure charcoal, and mild pot-aſh, mixed with a ſmall portion of iron, remains.

§ DXCV. Caſt iron differs from ſteel in its containing the iron in a ſemi-oxided ſtate; and from plumbago, in its containing a leſſer proportion of carbon. It poſſeſſes the fuſibility and brittleneſs of ſteel, but is incapable of receiving the ſame degree of hardneſs.

LXXVIII. OF TIN.

§ DXCVI. Tin (Jupiter) is the lighteſt of all metals, its ſpecific gravity being 7.3065. Its tenacity is inconſiderable; but it poſſeſſes a great degree of malleability, which is proved from its being wrought into thin plates. It is but ſlightly elaſtic, and ſo extremely ſoft as to receive an impreſſion from the nail of one's finger. It cauſes a ſingular crackling noiſe when bent.

§ DXCVII. Tin ſuffers no other change on expoſure to the atmoſphere than that its ſurface is ſomewhat tarniſhed; and for the ſame reaſon, water oxides it but ſlowly, and ſuperficially. It melts with great facility in the fire previous to ignition; and when melted in contact with air, its ſurface is oxided, and covered with a white ſhrivelled pellicle, which, being removed, is immediately ſucceeded by a ſecond pellicle, ſo that the whole maſs of tin may be converted into a calx, which is termed putty. But if tin be ſuddenly ignited, it burns with a white flame, and ſublimes at the ſame time in an oxided form.

§ DXCVIII. Melted tin difficultly cryſtallizes on cooling, when it forms rhomboidal cryſtals. A ſtrong fire changes the oxide of tin into glaſs, without the aid of a flux. But with vitrifiable bodies, it forms a white and opaque enamel. It is eaſily reduced to its metallic ſtate by the addition of inflammable bodies.

§ DXCIX. The concentrated ſulphuric acid, aided by heat, readily diſſolves tin, and on this occaſion ſulphureous acid gaz is produced. This ſolution is extremely cauſtic, and, being cooled, depoſits ſmall acicular cryſtals. A continued heat and reſt decompound the ſolution, and precipitate the oxide of tin, which is again diſſolved in an additional portion of ſulphuric acid. The fixed alkalis precipitate the tin from this ſolution in the ſtate of a very white oxide.

§ DC. The nitric acid acts very powerfully upon tin, which is changed into a white oxide, whilſt nitrous gaz is developed. The remaining nitric acid contains but a very ſmall portion of tin in ſolution, and even this is ſeparated during evaporation. This oxide of tin, when dried, forms a ſemi-tranſparent corneous ſubſtance. If a greater quantity of nitric acid be thus ſlowly and perfectly decompounded by tin, we obtain, on evaporating the water, a ſalt in the form of acicular cryſtals, which is true flaming nitre. For during this operation the water mixed with the nitric acid is alſo decompounded by the tin; its oxygen oxides the tin, and the hydrogen which is diſengaged combines with the nitrogen ſeparated from the nitric acid, and forms ammoniac, which, by uniting with a part of the remaining nitric acid, becomes flaming nitre.

§ DCI. The concentrated muriatic acid even in the cold acts upon tin, and diſſolves it, whilſt a very fetid inflammable gaz is produced. We obtain a yellow ſolution not decompoundable by reſt, which, being evaporated, forms beautiful brilliant acicular cryſtals, deliqueſcent in atmoſpheric air. Alkalis and lime precipitate the tin in the ſtate of a white oxide.

§ DCII. The oxygenated muriatic acid diſſolves tin quietly, and without efferveſcence. The tin, in this caſe, is oxided by the ſuperabundant oxygen, and then diſſolved in the remaining muriatic acid, which ſolution differs in no reſpect from the former. Tin is alſo readily diſſolved in aqua regia; the ſolution is yellow, and generally depoſits acicular cryſtals; but, if the ſolution be formed too haſtily, we ſhall obtain a gelatinous tranſparent maſs, the oxide of tin being ſeparated. (§ DLV. and DLVI.)

§ DCIII. Tin has a great tendency to combine with ſulphur; and, if thoſe two bodies be fuſed, they form a brittle ſemi-cryſtallized maſs, which is the ſulphuret of tin. By combining ſulphur with tin, we obtain alſo the ſubſtance termed aurum muſivum.—For this purpoſe you form an amalgam of eight parts of tin and the ſame quantity of mercury, and mix it with ſix parts of ſulphur and four parts of ſal ammoniac; this mixture, being expoſed to fire, in an open cucurbit, inflames, and a delicate ſublimate of a golden colour, or aurum muſivum, is obtained.

LXXIX. OF LEAD.

§ DCIV. Lead (Saturn) is the ſofteſt, the leaſt tenacious, and the leaſt elaſtic of all metals. Its ſpecific gravity is 11. 5523-1.0000. It is tarniſhed in the open air, and covered, by degrees, with a white cruſt, which is not, however, a pure oxide of lead, but a ſubſtance formed in ſome meaſure by the carbonic acid of the atmoſphere. Pure water produces ſcarcely any effect upon lead, and the oxidation obſerved on the ſurface of leaden pipes is rather to be attributed to heterogeneous particles contained in the water.

§ DCV. Lead melts by a gentle heat before it becomes ignited, and, when cooled, aſſumes the form of octaëdral cryſtals. But if the heat be very ſtrong, it ſublimes in the form of white fumes. Melted in contact with atmoſpheric air, it is ſoon covered with a grey pellicle, a true oxide of lead, into which the whole maſs may be converted by agitation. If this oxide be ſeparated from the particles of lead not yet calcined by means of a ſieve, and again heated till it becomes red hot, it aſſumes a yellow colour, and is then called maſſicot; which, if carefully and ſlowly heated for ſome time longer, aſſumes a deep red colour, being then termed minium. But, if the heat be increaſed too ſuddenly, both the maſſicot and the minium melt into a yellow ſemivitrified maſs, called litharge, which cannot be reduced to minium.

§ DCVI. If minium be heated in cloſe veſſels till it become red hot, it loſes part of its oxygen gaz, and becomes paler. By an intenſe heat it is changed into a yellow glaſs. When fuſed with a ſmall portion of common glaſs, it conſtitutes flint-glaſs, which refracts the rays of light much ſtronger, and forms, therefore, a neceſſary ingredient in the compoſition of the object glaſſes in achromatic teleſcopes. All the oxides of lead attract the carbonic acid of the atmoſphere with great eagerneſs; and ſhould, therefore, be kept in veſſels which are carefully cloſed.

§ DCVII. Lead is diſſolved in the ſulphuric acid only when boiling, on which occaſion ſulphureous acid gaz is developed, and the mixture is changed into a dry white maſs. This body conſiſts partly of pure oxide of lead, and partly of ſulphate of lead, which, being waſhed in hot water, and then evaporated, ſhoots into ſmall acicular cryſtals. This ſalt is very cauſtic. It requires 18 parts of water for ſolution, and is decompounded by alkalis, fire, and quicklime.

§ DCVIII. The concentrated nitric acid has a moſt powerful effect upon lead, which is changed into a white oxide, whilſt nitrous gaz is evolved. But, if the nitric acid be diluted, and taken in greater quantity, we obtain a true ſolution, which depoſits ſix-ſided priſmatic cryſtals. Theſe detonize on burning charcoal, and leave a yellow oxide of lead, which is eaſily reduced to its metallic ſtate. They are decompounded by alkalis and quicklime; alſo by the ſulphuric acid, which combines with the oxide of lead, on account of its greater affinity, and is precipitated with it in the form of a white powder.

§ DCIX. Although the muriatic acid act directly upon this metal, yet muriate of lead is much better prepared by adding the muriatic acid to a ſolution of nitrate of lead; for thus the muriatic acid combines with the oxide of lead, and is precipitated with it in the form of a white powder, named plumbum corneum, which requires 30 parts of boiling water for perfect ſolution, and cryſtallizes in ſmall needles. It is decompounded by alkalis, calcareous earth, and fire.

§ DCX. Sal ammoniac is decompounded by minium, and, if ſal ammoniac and minium be diſtilled in a retort, we obtain cauſtic ſpirit of ſal ammoniac, and plumbum corneum remains in the retort. In general, the oxides of lead are diſſolved in acids with the ſame facility as the metal itſelf.

§ DCXI. Lead combines very readily with ſulphur, and, if theſe two bodies be melted, we obtain a brilliant, ſemi-cryſtallized, brittle maſs, termed ſulphuret of lead. This ſubſtance reſiſts the action of fire much more than lead itſelf. Hepar of ſulphur diſſolves lead both in the moiſt and dry way.

LXXX. OF ANTIMONY.

§ DCXII. What is commonly termed antimony is not the pure ſemimetal of that name, but a ſubſtance generally compoſed of this ſemimetal and ſulphur, becauſe it is extracted in this ſtate from the mineral, and employed in commerce. Chemiſts, therefore, by way of diſtinction, uſually call the pure ſemimetal regulus of antimony. This metal is very brittle, and may be eaſily reduced to powder. Neither air nor water produces any particular effect upon it. Its ſpecific gravity is 6.7021-1.0000.

§ DCXIII. Antimony is difficult of fuſion, and does not melt till after it becomes red hot. It then volatilizes unaltered in a metallic ſtate, provided the proceſs be carried on in a cloſe veſſel. If gradually cooled, after fuſion, it cryſtallizes either in hexaëdral pyramids, or becomes a lamellated maſs, whoſe ſurface exhibits a ſtar. It is ſpeedily oxided when melted in open veſſels, emitting white fumes, which adhere to the ſides of the veſſel, or upon the ſurface of the metal, in the form of white aciculæ, called argentine flowers of antimony. Theſe flowers volatilize unaltered on expoſure to fire, and partly melt into a tranſparent glaſs of a pale yellow colour.

§ DCXIV. The ſulphuric acid acts upon antimony when boiled with it, a conſiderable quantity of ſulphureous acid gaz is developed, and, towards the end of the operation, even a ſmall portion of ſulphur. A maſs is thus formed, which conſiſts chiefly of the oxide of antimony, and of a ſmall quantity of ſulphate of antimony. The latter may be ſeparated from the former by waſhing; and thus we obtain an uncryſtallizable, deliqueſcent, neutral ſalt, decompoundable by fire, alkalis, alkaline earths, and even by water, if affuſed in great quantity.

§ DCXV. The nitric acid, even cold, acts very powerfully upon antimony; but alſo on this occaſion, moſt of the metal is merely oxided, and but a very ſmall part of it is taken up by the acid. This ſolution, after being evaporated, yields an uncryſtallizable ſaline maſs, which is decompounded by heat, alkalis, and abſorbent earths. The oxide of antimony, thus obtained, is very white, and not reduced to the ſtate of metal, except with the greateſt difficulty.

§ DCXVI. The muriatic acid does not act as powerfully upon antimony as other acids do, and it requires a long digeſtion to diſſolve it directly in this acid. If the ſolution be then evaporated, we obtain a deliqueſcent ſalt, in ſmall acicular cryſtals, which are decompoſed by water, and perfectly volatilized in fire; in ſhort, this ſalt is very ſimilar to butter of antimony.

§ DCXVII. The beſt and moſt perfect ſolvent of this ſemimetal is aqua regia, which acts upon it with great violence, and diſengages nitrous gaz. The neutral ſalt which is thus produced deliqueſces in the atmoſphere, and is decompounded by the alkalis and alkaline earths, in the ſame manner as the ſolutions of this ſemimetal are by the two other mineral acids.

§ DCXVIII. Regulus of antimony combines very readily with ſulphur; and, if equal parts of antimony and ſulphur be fuſed in a crucible, we obtain a cryſtallized ſtriated maſs, very ſimilar to antimony as extracted from the ore, but which contains only half its weight of ſulphur.

§ DCXIX. Sulphuret of antimony, or crude antimony, is more fuſible than the pure metal. If it be melted in an open veſſel, by an intenſe heat, the ſulphur is carried off in the form of yellow flowers, and the antimony which remains is ſublimed in the ſtate of a white oxide. But, by an uninterrupted gentle heat, by which the antimony does not melt, the ſulphur is gradually burnt, and the regulus of antimony remains in the ſtate of a grey oxide. For this purpoſe crude antimony, previouſly reduced to powder, is roaſted in a flat earthen veſſel, and continually ſtirred with the tube of a tobacco-pipe, till it ceaſes to ſmoke: ſhould the maſs adhere it ought to be pounded anew.

§ DCXX. If this grey oxide be expoſed to a ſtronger heat, in a crucible, it melts into a tranſparent glaſs of an hyacinthine colour, termed glaſs of antimony. But it is requiſite, for this purpoſe, that the antimony be not entirely deprived of its ſulphur, for otherwiſe we ſhall not obtain a beautiful glaſs, but merely a grey opaque maſs.

§ DCXXI. If equal parts of pulverized nitre and crude antimony be mixed, and thrown into a red hot crucible, a detonation takes place, and if the covered crucible be then kept in the fire for ſome minutes longer, we find, when cooled, that it contains a ponderous, hard, glittering, hepatic maſs, covered with grey ſcoriæ, termed liver of antimony. During this proceſs the nitre is decompoſed by the ſulphur of the antimony, for that part of the ſulphur which is changed into ſulphuric acid combines with one part of the alkali of the nitre and forms ſulphate of pot-aſh, whilſt the other part of the alkali combines with the ſulphur which is not changed, and forms ſulphuret of pot aſh. Theſe two bodies remain partly united with the regulus of antimony, with which they form ſulphuret of antimony, and partly with a ſmall portion of antimony only, thus forming the ſcoriæ.

§ DCXXII. Sulphuret of antimony is likewiſe prepared by melting crude antimony with the fixed alkalis. This ſulphuret, however, does not contain ſulphate of pot-aſh, but a greater portion of alkali, whence it deliqueſces in the atmoſphere.

§ DCXXIII. If ſulphuret of antimony, prepared as mentioned, (§ DCXXI.) be well waſhed in water, an oxide in antimony, combined with a ſmall portion of hepar of ſulphur, remains. This ſubſtance is known by different names, as Crocus antimonii, Crocus metallorum, &c. By evaporating the water we obtain ſulphate of pot-aſh, mixed with a certain portion of antimony.

§ DCXXIV. If rectified ſpirit of wine be affuſed and digeſted upon ſulphuret of antimony, (§ DCXXII.) while hot, we obtain a tincture of a cheſnut colour, commonly termed ſimple or tartarized tincture of antimony. The alcohol during this proceſs diſſolves a ſmall portion of the ſuperabundant alkali, which has become more cauſtic, and alſo a part of the oxide of antimony.

§. DCXXV. If the ſulphuret of antimony (§ DCXXI) be boiled in a great quantity of water, and then filtrated and cooled, it depoſits a brown powder, which, waſhed and dried, is known by the name of golden ſulphur of antimony of the firſt precipitation. The greateſt part of the oxide, combined with a ſmall portion of ſulphur, is here ſeparated from the hepar of ſulphur impregnated with a great portion of the metal.

§ DCXXVI. Now, if an acid, for inſtance the ſulphuric or acetic acid, be added by drops to the remaining liquid, a new precipitate is formed of a much fainter colour than the firſt, termed golden ſulphur of antimony of the ſecond precipitation. Laſtly, on the addition of more acid, we obtain a precipitate of an orange colour, called golden ſulphur of antimony of the third precipitation. The hepar of ſulphur is decompounded by the acids, and the ſulphur expelled; but the ſulphur precipitated firſt contains more of the oxide of antimony than the ſecond, and the laſt portion contains ſcarcely any; hence the variety of their colours.

§ DCXXVII. As the firſt of thoſe precipitates is never preſcribed in medicine, and the ſecond but very rarely, on account of their draſtic qualities; and as the power of the third is too variable and uncertain, we have of late adopted a method by which this medicine may be had, ſo as to contain a determinate proportion of the ſulphur and antimony moſt intimately combined. For this purpoſe two ounces of pulverized antimony, one and a half of flowers of ſulphur, and ſix of dry pot-aſh, are melted, and afterwards diſſolved in pure water. Or the mixture of antimony and flowers of ſulphur above-mentioned is boiled in an aqueous ſolution of cauſtic pot-aſh till perfectly diſſolved. In both caſes you filtrate the ſolution, dilute it with a great quantity of water, and add diluted ſulphuric acid till the precipitation entirely ceaſes. This precipitate, being edulcorated and dried, conſtitutes golden ſulphur of antimony, 100 parts of which contain always 25 parts of the oxide of antimony, and 75 parts of ſulphur.

§ DCXXVIII. Another medicine, ſimilar to the former, is kermes mineral, or pulvis carthuſianorum. One part of pulverized antimony and four parts of pot-aſh are boiled for a quarter of an hour with ſixteen parts of water in an iron pan; the ſolution, being filtrated and ſpontaneouſly evaporated, furniſhes a powder of a cheſnut-colour, which, edulcorated and dried, conſtitutes kermes mineral. Thus we prepare a ſulphuret of antimony in the moiſt way, which, by cooling, parts with the ſulphur and metal. One hundred parts of this kermes contain 48 parts ſulphur, and 52 parts of the oxide of antimony.

§ DCXXIX. If three parts of nitre, mixed with one part of pulverized antimony, be gradually thrown into a red hot crucible, we obtain, after detonation has taken place, a white maſs, called antimonium diaphoreticum non ablutum. As the quantity of nitre employed in the preparation of this ſubſtance is ſo very great, that not only all the ſulphur is changed into ſulphuric acid, and the antimony into a perfect oxide, but that even ſome of the nitre remains undecompounded, it is obvious, that the above medicine conſiſts of antimony highly oxided, ſulphate of pot-aſh, nitre, and a ſmall portion of pure pot-aſh.

§ DCXXX. If diaphoretic antimony be repeatedly waſhed in water, and thus freed from all other ſaline matter, there remains a white and perfect oxide of antimony, termed waſhed diaphoretic antimony. On the addition of an acid to the water we obtain another portion of oxide of antimony, which differs in no reſpect from the firſt, and was formerly called materies perlata. By cryſtallizing the ſolution we obtain a compound ſalt, viz. nitre of antimony.

§ DCXXXI. If four parts of pulverized antimony and four parts of corroſive ſublimate be well triturated in a glaſs mortar, and diſtilled over a gentle fire, from a glaſs retort with a ſhort neck, into a common receiver, a white maſs, ſimilar to butter, is ſublimed in the neck, and paſſes into the receiver on the application of burning charcoal. If the heat be increaſed, after this ſubſtance has ceaſed to come over, true cinnabar is ſublimed, and a certain portion of antimony is left in the retort.

§ DCXXXII. The ſublimate of mercury is here decompounded, for the oxygenated muriatic acid combines with the antimony, and forms butter of antimony; and the ſulphur, thus diſengaged, combines with the free mercury, and forms cinnabar, which is, however, alloyed with a ſmall quantity of antimony. It was formerly termed cinnabar of antimony. Should the butter of antimony be too brown, it may be purified and rendered colourleſs by repeated diſtillation.

§ DCXXXIII. Butter of antimony may be prepared in a much ſimpler way, by taking pure antimony inſtead of crude antimony; in this caſe, however, we obtain no cinnabar, but merely metallic mercury. But the moſt ſatisfactory way is to pour four ounces of diluted ſulphuric acid, in a retort, upon a mixture of two ounces of the grey oxide of antimony, or crocus metallorum, and four ounces of common ſalt, and to diſtil to dryneſs; for the muriatic acid which is expelled combines with the oxide of antimony, and forms butter of antimony, and the reſidue is ſal mirabilis.

§ DCXXXIV. Butter of antimony is an extremely cauſtic poiſonous body, which liquefies by a gentle heat, deliqueſces in the air, and, at the ſame time, depoſits the moſt conſiderable part of its oxide in a white pulverulent form. This decompoſition is effected ſtill quicker if the butter of antimony be mixed with water, which copiouſly precipitates this very pernicious oxide. It was formerly termed algaroth powder, or mercurius vitæ.

§ DCXXXV. Acids act more powerfully upon crude antimony than upon regulus of antimony, which is thus ſeparated from the ſulphur. This is beſt effected by aqua regia; for, if antimony be digeſted in this acid, the pure metal is gradually diſſolved, and the ſulphur remains in the ſtate of a white powder.

§ DCXXXVI. If the ſolution of antimony in aqua regia be evaporated to dryneſs, together with the ſulphur which is diſengaged, and the grey ſubſtance thus produced, mixed with an equal portion of the flowers of ſal ammoniac, be ſublimed in a cucurbit with an alembic, we ſhall obtain flowers of ſal ammoniac of a black, red, yellow, and grey colour; and, at the ſame time, a ſmall portion of ammoniac paſſes into the receiver. It is evident, therefore, that a part of the ſal ammoniac is decompoſed during the above proceſs, and that theſe flowers of ſal ammoniac conſiſt of the ſulphur of the antimony, and of the ammoniac combined with the muriate of antimony. They are extremely poiſonous. Their common name is Helmont's flowers of antimony.

§ DCXXXVII. Regulus of antimony is ſeparated from crude antimony in the following manner: two parts of pulverized antimony, mixed with three parts of crude tartar and one part of nitre, are gradually thrown into a red hot crucible; after detonation of the whole, the fire is increaſed till the maſs becomes perfectly fluid, when it is caſt into iron moulds, previouſly heated, and coated with wax or tallow. On cooling the moulds, the pure antimony is found at the bottom, covered with brown ſcoriæ.

§ DCXXXVIII. The detonation of the nitre and tartar produces what is termed a black flux, or a mixture of carbon and pot-aſh. This alkali combines, on account of its greater affinity, with the ſulphur of the antimony, and conſequently the metal is ſeparated. Although the carbon protects the metal, in ſome meaſure, againſt the power of the hepar of ſulphur, yet it is unable to do ſo for any length of time, as it ſoon begins to burn. Hence, when the maſs is perfectly melted, it ought to be poured into the mould, for otherwiſe we ſhall experience a conſiderable loſs of the metal. The ſcoriæ are compoſed of hepar of ſulphur, ſal polychreſt, and a ſmall portion of antimony.

§ DCXXXIX. Regulus of antimony is alſo ſeparated from crude antimony by different metals, ſuch as iron, ſilver, tin, &c. Theſe reguli of antimony, according to the metal employed for the precipitation, are termed martial, lunar, &c. reguli of antimony, by way of diſtinction from the former, which is commonly denominated ſimple or vegetable regulus of antimony. But, as the neceſſary proportion of theſe metals cannot be well determined, the reguli of antimony, thus obtained, are generally alloyed with part of the precipitating metal, and hence they are leſs pure than ſimple regulus of antimony.

§ DCXL. To prepare emetic tartar, equal parts of crocus metallorum and of purified tartar, in powder, are boiled in twelve parts of diſtilled water, the lixivium is then filtrated hot, and ſlowly evaporated till all the tartar has aſſumed a cryſtallized form. The ſuperabundant acid of tartar diſſolves the oxide of antimony, and cryſtallizes, together with the tartarized tartar, to which it communicates an emetic virtue; but, in order that this property may be equally diſtributed throughout the whole maſs, it ought to be reduced immediately to powder, and well mixed.

LXXXI. OF ZINC.

§ DCXLI. Zinc, on account of its malleability, approaches neareſt to metals; for, although it cannot be expanded under the hammer, yet it may be extended into very thin plates by means of flatting-mills, nor can we reduce it to powder. Its ſpecific gravity is 7.1908 : 1.0000. It is beſt granulated by water.

§ DCXLII. Zinc ſuffers but little change in atmoſpheric air. It melts as ſoon as it begins to be ignited, and ſublimes in cloſed veſſels without alteration. When ſlowly cooled it cryſtallizes in tetraëdral priſms. Melted in open veſſels it burns with a dazzling white flame, and emits white fumes, which ſubſide in the form of white flocculi, and conſtitute a true oxide of zinc, known by the name of flowers of zinc, nihil album, pompholix.

§ DCXLIII. Theſe flowers of zinc are one-fourth heavier than the zinc made uſe of, and are not volatile per ſe; for, when heated in a crucible, they remain fixed, and emit a yellow phoſphoreſcent light. They are ultimately reduced to a beautiful tranſparent glaſs by an exceedingly violent heat. Upon burning coals, the flowers of zinc, if pure, become yellow, by which means we may diſcover their adulteration with chalk.

§ DCXLIV. Water produces the ſame effect upon zinc, when heated, as upon iron; and if water or aqueous vapours be brought into contact with zinc, when it begins to acquire a red heat, a ſtrong oxidation takes place, and a conſiderable quantity of hydrogen gaz is obtained, but always mixed with carbon, for zinc generally contains ſome portion of carbon.

§ DCXLV. Diluted ſulphuric acid diſſolves it very eaſily; much inflammable gaz is developed, and a black powder, which is plumbago, or carburet of iron, is generally ſeparated. The ſolution, when evaporated, affords a white ſalt in tetraëdral priſmatic cryſtals, with tetraëdral pyramidal extremities, termed white vitriol, vitriol of zinc, ſulphate of zinc. This ſalt has an aſtringent taſte. It is partly decompounded on expoſure to the air or fire, and very perfectly by the earths and alkalis.

§ DCXLVI. The nitric acid, even in the cold, acts upon zinc, and diſſolves it. During the ſolution nitrous gaz is developed, and a ſmall portion of plumbago ſeparated. The ſolution is greeniſh, and, when evaporated and cooled, depoſits flat tetraëdral priſmatic cryſtals, with ſimilar extremities, which detonate on burning coals, and are decompounded by alkalis and alkaline earths.

§ DCXLVII. The muriatic acid acts as violently upon zinc as the nitric acid; but, in this caſe, inflammable gaz is formed, and plumbago precipitated. The ſolution affords no cryſtals, and a partial decompoſition of it is effected even by a gentle heat. If it be diſtilled from a retort we obtain a ſmall portion of fuming muriatic acid, and the remaining muriate of zinc comes over as a butyraceous maſs. This ſalt is alſo decompounded by alkalis and alkaline earths.

§ DCXLVIII. If the acid ſolutions of zinc abovementioned be decompounded, either by alkalis or alkaline earths, a white or yellow oxide of zinc, ſoluble in acids and alkalis, is precipitated. Hence, if during the precipitation of zinc, more alkali be employed than is neceſſary to ſaturate the acid, the precipitate diſappears, being re-diſſolved.

§ DCXLIX. It is very difficult to effect a combination of zinc and ſulphur, either in the moiſt or dry way, by artificial means. Nevertheleſs an union of theſe two bodies may be effected by continued fuſion, when an artificial blende is obtained. As ſulphur combines more readily with lead than with zinc, we therefore make uſe of it to ſeparate zinc from lead.

§ DCL. Zinc and copper, combined in various proportions, form thoſe compound metals known by the names of braſs, tomback, prince's metal, ſpinſpeck, manheim gold, &c. Theſe compounds are harder, and more fuſible than copper, and are leſs liable to tarniſh. They are prepared either by melting the two metals, or by the cementation of lamellæ of copper between ſtrata of the native oxide of zinc or lapis calaminaris.

LXXXII. OF BISMUTH.

§ DCLI. Biſmuth is a ſemimetal of a large foliated texture, whoſe ſpecific gravity is 9.8227-1.0000. Although at firſt it ſlightly yield under the hammer, yet it is ſufficiently brittle to be reduced to powder.

§ DCLII. Biſmuth, on expoſure to the air, is tarniſhed, and ultimately covered with a whitiſh ochre. It is very fuſible, and melts long before it becomes red hot; it is then ſublimed in cloſed veſſels, without alteration; and, if gradually cooled, readily cryſtallizes into many-angled columns. But, if this ſemimetal be melted in contact with the air, its ſurface is oxided, and becomes a grey greeniſh powder. When thus heated to ignition, it burns with a faint blue flame and a yellow ſmoke, which condenſes in contact with colder bodies, in the form of a yellow powder, termed flowers of biſmuth. Theſe flowers remain fixed in the fire, but, by an intenſer heat, they melt into a greeniſh glaſs.

§ DCLIII. Biſmuth is diſſolved in concentrated and boiling ſulphuric acid, a ſmall quantity of ſulphureous acid gaz is produced, and a white maſs, which conſiſts chiefly of the oxide of biſmuth and ſulphate of biſmuth, remains. The latter may be ſeparated by waſhing, and affords, when evaporated, ſmall needle-like cryſtals. This ſalt deliqueſces on expoſure to the air, and is decompounded by alkalis, alkaline earths, fire, and even by water, when affuſed in ſufficient quantity.

§ DCLIV. The concentrated nitric acid has a very powerful effect upon biſmuth, even in the cold; a conſiderable quantity of nitrous gaz is developed, and the colourleſs ſolution obtained furniſhes, by evaporation, ſometimes rhomboidal and, at other times, priſmatic cryſtals, which detonate ſlowly in the fire, and leave a green oxide. This ſalt effloreſces in the atmoſphere, and is decompounded when diſſolved in water, the greateſt part of the oxide of biſmuth being precipitated in the form of a white powder. The ſame effect is produced if a ſaturated nitric acid ſolution of biſmuth be diluted in water. The precipitate, formed in that caſe, is termed magiſtery of biſmuth.

§ DCLV. The muriatic acid acts with great difficulty upon biſmuth, and only when concentrated and digeſted upon it for a long time: a fetid gaz is developed, and that part of the biſmuth which is actually united with the acid may be ſeparated by waſhing it with water. This ſalt affords no cryſtals, but may be ſublimed, in which caſe it forms a ſoft fuſible maſs, termed butter of biſmuth. It is likewiſe decompounded by water.

§ DCLVI. Sulphur readily combines with it by fuſion, and forms a blueiſh-grey artificial ore, cryſtallizable in beautiful tetraëdral aciculæ. Biſmuth combines alſo with tin and lead. Eight parts of biſmuth, melted with five parts of lead and three parts of tin, produce a compoſition which melts at the temperature of boiling water.

LXXXIII. OF NICKEL.

§ DCLVII. Nickel is now conſidered by all Chemiſts as a peculiar ſpecies of ſemimetal, although it be very difficult to obtain it perfectly pure, it being always mixed with cobalt and iron. In its pureſt ſtate it has a granular texture, and is attracted by the load-ſtone. Its ſpecific gravity is 7.8070. It is tenacious and ſomewhat malleable.

§ DCLVIII. An intenſe heat is required to fuſe it. When expoſed to fire, in contact with the atmoſphere, its ſurface is oxided, and becomes a green powder, which, melted with borax, forms a glaſs of an hyacinthine colour.

§ DCLIX. If the oxide of nickel be treated in the fire with ſulphuric acid, it will be changed into a grey maſs, and ſulphureous acid gaz will be produced. This maſs, diſſolved in water, affords a beautiful green ſolution, which, when evaporated, depoſits beautiful green decaëdral cryſtals, decompoundable by fire.

§ DCLX. The nitric acid combines both with metallic nickel and with its oxide. We obtain a green ſolution, which affords green lamellated cryſtals, deliqueſcent in the atmoſphere. The muriatic acid produces the ſame effect, and, together with the nickel, ſhoots into green rhomboidal cryſtals, which are decompounded in the air.

§ DCLXI. Nickel, combined with ſulphur, conſtitutes a yellow brittle maſs. The oxide of nickle is diſſolved in the moiſt way by the fixed alkalis, and, likewiſe, by cauſtic ammoniac, with which it forms a dark blue ſolution.

LXXXIV. OF COBALT.

§ DCLXII. Cobalt has a fine, cloſe, granular texture. Its ſpecific gravity is 7.8819–1.0000. It is ſcarcely malleable, and may be eaſily reduced to powder. On expoſure to fire, it melts after it has been red hot ſometime, and provided the heat be intenſe. Being then gradually cooled, it cryſtallizes in acicular cluſters.

§ DCLXIII. Although cobalt, fuſed in contact with the air, is a little oxided on its ſurface, yet this oxide is formed much more readily, and in greater abundance, if regulus of cobalt, reduced to powder, be ſtrongly heated in a flat veſſel. The oxide of cobalt, thus obtained, is black, and requires a very intenſe heat to be melted by itſelf into a dark blue glaſs. With vitrifiable bodies and pot-aſh, however, it melts more eaſily, and forms a glaſs more or leſs blue, which, being reduced to powder, conſtitutes ſmalt. Zaffre conſiſts of a mixture of the oxide of cobalt and very fine ſand.

§ DCLXIV. A combination of cobalt with the ſulphuric acid is beſt effected by digeſting the oxide of cobalt in diluted ſulphuric acid. The ſolution, obtained in this manner, is of a roſe-colour, and, when evaporated, ſhoots into rhomboidal cryſtals of the ſame colour, which diſſolve in ſpirit of wine, effloreſce in the atmoſphere, and are decompounded in the fire.

§ DCLXV. The nitric acid diſſolves cobalt both as a metal and as an oxide, and, by evaporating the ſolution, forms cryſtals of a brown red colour, which deliqueſce in the air, and are decompounded by fire. The muriatic acid alſo diſſolves the oxide of cobalt with great facility. This ſolution is of a pale red, and, when evaporated, affords pale green acicular cryſtals, ſoluble in ſpirit of wine, and decompoundable by fire.

§ DCLXVI. This ſolution, as well as the aqua-regia ſolution of cobalt, poſſeſſes the ſingular property, that, when diluted with water, and uſed as an ink, the letters are inviſible, but appear of a beautiful green colour when heated. This ſympathetic ink is beſt prepared by adding culinary ſalt to a ſolution of nitrate of cobalt, for thus the nitric acid is changed into aqua regia, and the nitrate of ſoda, produced at the ſame time, prevents the paper from being eroded.

§ DCLXVII. The moſt ſimple method of obtaining cobalt in its metallic ſtate conſiſts in reducing it from ſmalt. To this end, one part of ſmalt is fuſed in a crucible with ſix parts of ſoda; the maſs, thus formed, being cooled, regulus of cobalt is found at the bottom of the crucible, covered with a ſcoria, which is ſoluble in water, formed by the combination of ſoda with the ſiliceous earth of the ſmalt.

LXXXV. OF MANGANESE.

§ DCLXVIII. We have long known a mineral under the name of ſoap of the glaſs-makers, which is much uſed in ſeveral manufactories, and was formerly conſidered by mineralogiſts as an iron ore. Within theſe few years, however, it has been proved that this body is a metallic oxide, which may be reduced into a ſemimetal of a peculiar kind, termed manganeſe. This ſemimetal has a granular fracture, and is extremely brittle and hard. Its ſpecific gravity is from 6.850 to 7.000 : 1.000.

§ DCLXIX. Manganeſe, when expoſed to the atmoſphere, is ſoon tarniſhed, and, by degrees, entirely converted into an oxide. Heated in contact with atmoſpheric air, it is quickly oxided, and reduced to a black calx, the colour of which is deeper in proportion to the quantity of oxygen with which it combines. This oxide of manganeſe tinges glaſs, when melted with it, either of a brown or blueiſh colour, which vaniſhes when acted upon by inflammable bodies, but is reſtored by means of nitre. A moſt intenſe heat is requiſite for the fuſion of this metal.

§ DCLXX. If the native oxide of manganeſe be treated in cloſed veſſels, it parts with a conſiderable portion of its oxygen, but, nevertheleſs, it cannot be reduced per ſe. In order to obtain metallic manganeſe, a ſmall portion of the oxide ſhould be ſtrongly heated, and afterwards formed into a paste, by means of oil and fat, which, being expoſed for an hour in a crucible filled with powdered carbon, to the moſt violent heat that can be raiſed, metallic manganeſe will be found at the bottom of the crucible.

§ DCLXXI. Manganeſe is eaſily diſſolved in diluted ſulphuric acid, with diſengagement of hydrogen gaz. But this acid diſſolves the oxide of that metal only when concentrated and boiling. The ſolution, in both caſes, furniſhes, by evaporation, a reddiſh ſalt in rhomboidal cryſtals, which have an acrid taſte, and afford, when ſtrongly heated, a ſmall portion of oxygen gaz and pure ſulphuric acid.

§ DCLXXII. The nitric acid diſſolves manganeſe, with diſengagement of nitrous gaz. But the oxide of this metal is diſſolved only in fuming ſpirit of nitre. In both caſes, the ſolution, when evaporated, ſhoots into tabulated cryſtals, which deliqueſce in the atmoſphere, and, on expoſure to fire, emit oxygen gaz and nitric acid.

§ DCLXXIII. The muriatic acid diſſolves manganeſe, as well as its oxide, with facility. During the ſolution of the latter, oxygenated muriatic gaz is developed, and the ſolution, when evaporated, affords a ſaline maſs, which ſpeedily deliqueſces in the atmoſphere.

§ DCLXXIV. If the oxide of manganeſe be treated in fire with ſulphur, a ſmall portion of ſulphureous acid is produced, and a yellowiſh green ſubſtance, which is ſulphuret of manganeſe, remains. If one part of the native oxide of manganeſe, and three parts of nitre, be melted in a crucible till no more oxygen gaz is diſengaged, we obtain a greeniſh friable powder, termed Chamœlion mineralis, This ſubſtance, diſſolved in common water, forms a green ſolution, which ſoon changes to a violet, and laſtly to a red colour. If a ſmall portion of acid be previouſly added to the water, the ſolution becomes red immediately, and, if the pureſt diſtilled water be employed, it will continue green for a long time.

LXXXVI. OF ARSENIC.

§ DCLXXV. Arſenic is very brittle and hard. Its ſpecific gravity, to that of water, is 5.7633-1.0000. It loſes it metallic ſplendour when expoſed to the atmoſphere, and firſt becomes yellow, and afterwards black. It undergoes no alteration when ſublimed in cloſed veſſels, but ſhoots into triaëdral, columnar, and pyramidal cryſtals. Melted in open veſſels it inflames, and paſſes off in the form of a white oxide, diffuſing, at the ſame time, a peculiar ſmell like onions. This oxide adheres to the cooler bodies which ſurround it; and, according as it is more or leſs ſolid, it is termed white arſenic, or glaſs of arſenic.

§ DCLXXVI. The oxide of arſenic differs from all other metallic oxides in this, that it is ſoluble in water, poſſeſſes an acrid taſte, and combines with the fixed alkalis in the moiſt way, forming a brown inſpiſſated maſs, termed hepar of arſenic. It alſo combines with thoſe alkalis in the dry way, and produces a white and very fixed ſubſtance, formerly called fixed arſenic.

§ DCLXXVII. The ſulphuric acid acts upon regulus of arſenic only when concentrated and aided by heat, and even in that caſe no perfect ſolution is formed, as the metal is merely oxided. But boiling muriatic acid diſſolves both the regulus of arſenic and its oxide, and we obtain a ſolution which is decompoundable by fire and alkalis.

§ DCLXXVIII. If twelve parts of concentrated nitric acid be gradually affuſed upon one part of white arſenic, in a tubulated retort, a conſiderable quantity of nitrous gaz is diſengaged, and a white ſubſtance remains, which may be freed from the nitric acid ſtill adhering by heating it in a crucible. On this occaſion the nitric acid is, by degrees, perfectly decompounded by the arſenic, becauſe this latter body combines with the greateſt part of the oxygen of the former, and thus becomes an acid itſelf, which is termed arſenic acid.

§ DCLXXIX. The arſenic acid is extremely fixed, and melts per ſe into a tranſparent glaſs. It is perfectly ſoluble in twice its weight of water. Saturated with pot-aſh, it forms a neutral ſalt, which ſhoots into large rhomboidal cryſtals, not deliqueſcent in the air, but vitrifiable in fire. Combined with ſoda, it forms a ſalt in octaëdral cryſtals, which effloreſce in the atmoſphere.

§ DCLXXX. Both the regulus of arſenic and white arſenic may be readily united with ſulphur by fuſion. This ſulphuret of arſenic is perfectly ſublimed in cloſe veſſels, and becomes either yellow or red, according to the proportion of its conſtituent parts. The former is termed yellow arſenic, or orpiment, which contains about ten parts of arſenic, and one part of ſulphur. In the latter, however, which is denominated red arſenic, the proportion of the ſulphur to the arſenic is equal 1 : 4.

§ DCLXXXI. Nitre is decompounded by white arſenic, and, if this mixture be diſtilled in a retort, fuming ſpirit of nitre is obtained, and arſeniate of potaſh remains. The ſame happens if nitre and arſenic be detonated in a red-hot crucible.

§ DCLXXXII. If equal parts of the regulus of arſenic and of corroſive ſublimate be diſtilled, we acquire an inſpiſſated liquor, viz. butter of arſenic. During this proceſs, the ſublimate is decompounded, the oxygenated muriatic acid combines with the regulus of arſenic, and forms butter of arſenic, and the mercury is reduced. White arſenic does not decompound the ſublimate, but is ſublimed with it, without ſuffering any change.

§ DCLXXXIII. Almoſt all metals combine with arſenic, and, in conſequence, become brittle. With copper, it forms an alloy, of the colour of ſilver, which admits of a beautiful poliſh, and which is called by the French *argent haché*. This alloy is commonly prepared by melting copper with fixed arſenic and powdered carbon.

LXXXVII. OF TUNGSTEN.

§ DCLXXXIV. Mineralogiſts have long been acquainted with a mineral, which, on account of its peculiar gravity, is termed tungſten, or the ponderous ſtone. Some conſidered it as a mineral of iron, others as a mineral of tin, but experiments proved both theſe opinions to be unfounded. Bergmann, in conſequence of a very accurate inveſtigation, proved this foſſil to be a true earthy ſalt, compoſed of calcareous earth and a peculiar acid, which he termed acid of tungſten.

§ DCLXXXV. A ſhort time after, another doubtful mineral, named wolfram, being examined with equal attention, was found to conſiſt of the ſame acid, beſides manganeſe and iron. Mr. D'Elhuyar, at length, diſcovered, that this acid could be reduced to a true regulus of metal, and that it was, therefore, a metallic acid. Since that time, this metal has been denominated tungſten, and its acid the tungſtic acid.

§ DCLXXXVI. According to Sheele's method, the acid is extracted from tungſten in the following manner: one part of pulverized tungſten is digeſted in three parts of diluted nitric acid, by which means the powder becomes yellow. On the addition of two parts of pure ammoniac, the acid being effuſed, the powder becomes white, three parts of nitric acid are then added anew, and the yellow colour is again removed by ammoniac. This proceſs is continued till the tungſten is diſſolved, for which purpoſe we require about 12 parts of nitric acid, and eight parts of ammoniac. A very ſmall portion remains undiſſolved, which appears to be ſiliceous earth. The nitric acid ſolution is then precipitated by pot-aſh, and the ammoniacal ſolution by nitric acid.

§ DCLXXXVII. Tungſten is diſſolved in the nitric acid which combines with the calcareous earth, and leaves the tungſtic acid in the form of a yellow powder, which, having a great affinity with ammoniac, forms a ſoluble neutral ſalt with it. Hence we obtain two liquid ſolutions, one conſiſting of nitric acid and calcareous earth, and the other of pure ammoniac and tungſtic acid. The calcareous earth of the former may be precipitated by pot-aſh, and the tungſtic acid of the latter by the nitric acid, which forms, with the ammoniac, nitrate of ammoniac, a ſubſtance inſoluble in the tungſtic acid, whence it is precipitated. The ſmall portion of ſiliceous earth, generally contained in the ponderous ſtone, remains after the firſt operation, and, ſhould it be mixed with any particles of iron, they may be precipitated by pruſſiate of pot-aſh.

§ DCLXXXVIII. To ſeparate the tungſtic acid from Wolfram, melt one part of pulverized Wolfram with three parts of dry ſoda; diſſolve this melted maſs in water; filtrate the ſolution, and precipitate it by nitric acid: thus you obtain a white powder, which is the tungſtic acid. On this occaſion, the iron, combined with the tungſtic acid, is precipitated by the ſoda, and left on filtration, and the tungſtic acid is diſengaged from the tungſtate of ſoda by the nitric acid.

§ DCLXXXIX. If the tungſtic acid, obtained by either of the proceſſes we have mentioned, be expoſed to the action of a blow-pipe, it becomes firſt yellow, then brown, and laſtly black, and is neither melted nor volatilized. It requires twenty parts of boiling water for ſolution, which tinges the ſyrup of violets red, and has an acrid metallic taſte. With the nitric and muriatic acids it becomes inſtantly yellow, and, heated with ſulphuric acid, blue.

§ DCXC. With pot-aſh, ſoda, and ammoniac, it forms true neutral ſalts, which ſhoot into ſmall acicular cryſtals, and are even more ſoluble in water than the tungſtic acid itſelf. With lime-water it generates artificial tungſten, which, as well as native tungſten, is perfectly inſoluble in water.

§ DCXCI. If the tungſtic acid be mixed with powdered carbon, and expoſed, in a crucible, to an intenſe heat, we obtain metallic tungſten, in ſmall globules, the ſpecific gravity of which is 17.600–1.000. It is extremely difficult of fuſion, but it is eaſily reduced to a yellow powder. The three mineral acids have no effect upon it.

LXXXVIII. OF MOLYBDENA.

§ DCXCII. Molybdena is a peculiar mineral which mineralogiſts have long confounded with plumbago; but Sheele demonſtrated that thoſe two bodies are very different from each other in their chemical properties, and that native molybdena contains a true metallic acid, which Hielm and Pelletier afterwards reduced to a true metal.

§ DCXCIII. To ſeparate the oxide of molybdena, or the molybdic acid, from molybdena, one part of molybdena is gradually digeſted in a retort, with 30 parts of nitric acid, ſix parts of the acid being affuſed at a time; thus a conſiderable quantity of nitrous gaz is produced, and there remains, at laſt, a white powder, which, when repeatedly waſhed in cold water, is the pure molybdic acid. During this operation the nitric acid is decompounded, for its oxygen combines with the metal, which, in conſequence, becomes an oxide, whilſt the nitrous gaz is carried off. Should the native molybdena contain ſulphur, it would, during this proceſs, be alſo changed into ſulphuric acid, but would, at the ſame time, be ſeparated from the molybdic acid by the water. A diſengagement of the molybdic acid from native molybdena is effected, likewiſe, by cauſing the latter to be gradually roaſted under a muffle, when the acid remains in a cryſtallized form.

§ DCXCIV. The molybdic acid is ſoluble in boiling water, to which it communicates a peculiar acidulous metallic taſte, and the property of changing the tincture of turnſole red. By heat it combines with the ſulphuric acid, and becomes blue and thick when cooled. But each of theſe phenomena diſappears on expoſure to heat. It produces nearly the ſame effect with the muriatic acid, the ſolution of which, when evaporated to dryneſs, affords a blue powder.

§ DCXCV. The molybdic acid, when heated in contact with atmoſpheric air, is entirely volatilized, and ſublimes in the form of ſmall acicular cryſtals. With pot-aſh it produces a neutral ſalt which is very ſoluble in water, and ſhoots, on cooling, into ſmall needles, which are not volatilized when expoſed to the action of fire. It combines with various metals, with which it forms blue ſolutions.

LXXXIX. OF URANITE.

§ DCXCVI. Pech-blende, a body of which mineralogiſts have entertained different opinions, appears, from the experiments of the celebrated Klaproth, to be the ore of a ſemimetal, which differs in its properties from all thoſe hitherto known, and to which he gave the name of uranite. To extract it from pech-blende, which is a compound of uranite, ſulphur, and iron, you digeſt it for ſome time in concentrated nitric acid, and precipitate the filtrated ſolution by pot-aſh, when a yellow powder, viz. oxide of uranite is obtained. During this proceſs the oxide of uranite is diſſolved in the nitric acid, and the ſulphur and iron remain.

§ DCXCVII. By treating the oxide of uranite with combuſtible bodies, Mr. Klaproth obtained ſeveral coherent particles of metal, which proved to be the metal uranite. There is no metal which fuſes with ſuch extreme difficulty as this. Its ſpecific gravity is 6.440–1.000. It is ſoluble in the three mineral acids, with which it forms earthy ſalts, decompoundable by alkalis, which, if mild, and affuſed to exceſs, again diſſolve the precipitate.

THE VEGETABLE KINGDOM.

XC. EXAMINATION OF VEGETABLE BODIES IN A DEGREE OF HEAT EQUAL TO THAT OF BOILING WATER.

§ DCXCVIII. A living and growing plant draws its nutriment partly from the earth, to which it is attached by means of its roots, and partly from the atmoſphere, by means of its extenſive ſurface, covered with abſorbent veſſels. As an organized body, it does not ſtand in need of the whole of the aliments with which it is furniſhed in each of theſe ways, nor in an unchanged ſtate; but after a continued circulation, and after they have been variouſly reſolved, the plant again throws off the ſuperfluous part.

§ DCXCIX. The chief nutriment of a plant is water, and ſuch æriform bodies as it may imbibe from the atmoſphere. Hence, its excrements are gazeous ſubſtances, water, and odoriferous particles. The former are not always the ſame, but differ according to circumſtances and the nature of the plant. Flowers, moſt fruits, roots, and all except the green parts of vegetables, under whatever circumſtance, give out azotic and carbonic acid gaz; but the leaves, and all the green parts of vegetables, expire oxygen gaz nearly pure, when expoſed to the ſolar light; in the ſhade, and by night, however, like flowers, they yield azotic and carbonic acid gaz only.

§ DCC. The water, which living plants exhale, under the common temperature of the atmoſphere, is ſometimes very pure, but moſtly impregnated with odoriferous particles, if the plant poſſeſs any ſuch.—To obtain this water, a freſh plant is expoſed in a cloſe veſſel, to a temperature ſcarcely exceeding that of ſolar heat; that is, it is diſtilled in a heat of about 30°, when pellucid and limpid water, containing all the parts of the plant volatile at this temperature, will flow into the receiver. What remains of the plant, ſuppoſing the operation to have been continued for a ſufficient length of time, is dry, friable, deſtitute of all odour and humidity.

§ DCCI. This water is therefore preciſely the ſame as that which the plant emits in the heat of the ſun; nor does it carry any thing elſe along with it, except ſometimes a ſmall proportion of ætherial oil, than that principle of plants which produces odour.—This principle cannot be perceived either by the eye or taſte, but by the ſmell alone. Hitherto Chemiſts have not been able either to exhibit it ſingly, or to reſolve it into its component parts; wherefore they conſider it as a ſimple ſubſtance, and term it aroma, or, according to Boerhaave, ſpiritus rector.

§ DCCII. It is very evident, that all plants, which affect the ſenſe of ſmell, contain aroma, or ſpiritus rector; but whether all thoſe plants which do not ſo affect us are entirely deſtitute of aroma is a queſtion hitherto undecided. We frequently obſerve animals diſtinguiſh plants by their ſenſe of ſmelling, in which man cannot perceive the leaſt odour; which ſeems, therefore, to be rather attributable to a leſs acuteneſs in the organ of ſmell in man than to a total defect of aroma in ſuch plants.

§ DCCIII. The aroma in ſome plants ſmells deliciouſly, in others it is altogether ungrateful, in others it ſimply ſtimulates; but theſe properties are alſo relative with reſpect to different men. Not every part of the ſame plant poſſeſſes the ſame ſpecies of aroma, for the flowers frequently give out a very different odour from the leaves, &c. nor do all the parts of the ſame plant poſſeſs the ſame ſtrength of aroma, although they poſſeſs aroma of the ſame kind; thus the leaves are often more fragrant than the ſtem or flowers, and ſo on. Finally, plants do not at all times contain the ſame quantity; in general they poſſeſs moſt of it when arrived at maturity.

§ DCCIV. Though all aroma be volatile, yet its degree of volatility is oftentimes very different. In moſt plants it cannot bear the heat of boiling water, and in ſome, the jeſſamin for example, it flies off on the ſlighteſt addition of heat. There are plants, however, ſuch as ſaffron, valerian, &c. which are ſtill odoriferous after the evaporation of all their water. Aroma, held in ſuſpenſion by water alone, is gradually diſſipated or deſtroyed, and that even in the cloſeſt veſſels.

§ DCCV. From the preceding obſervations we know:

1. Of what principles the effluvia of plants, vegetating in the heat of the ſun, conſiſt, viz. of oxygen gaz, water, aroma, and frequently of a volatile oil.

2. How we may account for the effects which have been frequently produced by the effluvia of plants growing in great numbers near each other.

3. That nothing can be expected from dried plants, whoſe medicinal virtues depend on aroma alone.

4. That thoſe plants, which when dried, ſtill retain a conſiderable portion of aroma, ought to be dried for medical purpoſes with caution, and always in the ſhade; nor ſhould they be kept in a warm place.

XCI. OF INFUSION.

§ DCCVI. If hot water be affuſed upon a recent or dried plant, and thus ſuffered to remain, for a ſhort time, in a cloſe veſſel, the water, afterwards decanted from the plant, is termed an infuſion. During this operation, not only all the aroma and ſome etherial oil are taken up by the infuſion, but alſo many other parts ſoluble in water, ſuch as gum, mucilage, the colouring matter, ſalts, &c. ſo that the plant remains deprived of its aroma, and, in a great meaſure, of its ſapidity.

§ DCCVII. The quantity of the parts diſſolved in the water, independent of aroma, differs according to the quantity and temperature of the water employed; and alſo on account of the greater or leſs protraction of the ſolution. The particles which are diſſolved at the beginning of the infuſion frequently differ very eſſentially from thoſe which are diſſolved towards the end. The water is, in the firſt inſtance, impregnated with the aroma and volatile oil; and laſtly, with the colouring, aſtringent, and gummy parcles; whence a ſlight infuſion is oftentimes grateful to the palate, whilſt a protracted one, of the ſame plant, is bitter and acerb.

DCCVIII. If, therefore, an infuſion be made for medical purpoſes, the phyſician ought to ſtate the quantity and temperature of the water to be employed, as well as the time of infuſion, according as he wiſhes it to be impregnated more or leſs copiouſly with particles of this or that deſcription. For this reaſon infuſions are alſo frequently made of vegetables deſtitute of all aroma; for example, tender parts of plants, ſuch as flowers, which decoction would entirely deſtroy, or vegetables of that kind which during decoction would depoſite reſinous parts, that might be productive of injury, when uſed internally, &c.

§ DCCIX. Sometimes Phyſicians alſo direct plants to be merely macerated in water, or digeſted.

XCII. OF DECOCTION.

§ DCCX. If the whole or any part of a plant be expoſed for ſome time to water of ſuch temperature that it boils, the operation, as well as the water afterwards poured off, is termed decoction.

§ DCCXI. Since, during this proceſs, the water may act upon the plant, both for a longer time, and at a higher temperature, a much greater quantity of ſuch parts, as are capable of ſolution in water, are obtained in decoction, which for the ſame reaſon is much darker and more ſapid than an infuſion. But the aroma, which is for the moſt part volatile at the temperature of boiling water, is almoſt always diſſipated, ſo that little of it remains in the decoction.

§ DCCXII. Plants, whoſe virtues conſiſt in the volatile parts, ought not, therefore, for medical purpoſes, to be ſubmitted to decoction. On the other hand, thoſe whoſe efficacy depends upon their fixed principles, ought to be decocted rather than infuſed; nevertheleſs, there are in this caſe exceptions.

1. Tender flowers are better infuſed than decocted, as the water is ſufficiently powerful to extract their virtues; and as boiling water would entirely deſtroy them, and render the decoction unneceſſarily turbid.

2. Plants, deſtitute of aroma, are frequently infuſed, leſt a higher temperature and protracted decoction ſhould cauſe too great a quantity of reſinous particles to be diſſolved in the water, which might produce gripings in the bowels, &c. when internally uſed.

§ DCCXIII. By repeated decoction in water, every time freſh, all the ſoluble parts of a plant may be at length extracted; but this proceſs is extremely tedious. For medicinal purpoſes, the time of decoction, as well as the quantity of water made uſe of, ought to be determined according to circumſtances.

§ DCCXIV. The time neceſſary for decoction is determined:

1. From the texture of the plant to be decocted, which frequently, on this account, requires a mechanical preparation, as cutting, bruiſing, &c.

2. From the degree of ſaturation which a Phyſician wiſhes his decoction to poſſeſs.

3. From what we know by experience of ſome plants; as for example, that the purgative virtues of rhubarb are gradually diminiſhed by decoction, whilſt, on the other hand, its aſtringent virtues increaſe; that myrobalan, decocted for a ſhort time only, is cathartic, but that it becomes an aſtringent when boiled longer; that licorice, by continued decoction, loſes its agreeable ſweetneſs; and that opium, in like manner, is deprived of its narcotic qualities, and ſo on.

§ DCCXV. The quantity of water is to be determined by

1. The time of the decoction.
2. The bulk of the plant.
3. Its texture. And
4. The deſign of the phyſician.

But as the three former points are better known to the pharmaceutical Chemiſt than to the Phyſician, from his daily practice, the quantity of water to be employed is left to his judgment; and the phyſician merely ſtates the quantity of decoction he wiſhes to obtain.

§ DCCXVI. Sometimes in compound decoctions not all the parts ſhould be put into water at the ſame time, but ſucceſſively, according to the individual properties of each.

§ DCCXVII. The force of ebullition always deſtroys, in a certain degree, the texture of plants, and cauſes ſome of its ſolid parts to be torn off; whence the decoction becomes turbid. This is clarified or rendered pure, firſt, by filtration; ſecondly, by decanting the refrigerated decoction from the depoſited ſediment; and thirdly, by repeated decoction with the white of egg, beat into foam, and ſubſequent filtration.

§ DCCXVIII. The reſinous parts of plants, which are frequently diſſolved by the heat and the other components, ſubſide for the moſt part on cooling, and form a ſediment, or are ſeparated by the clarification with white of egg. Decoctions, for this reaſon, frequently loſe much of their effect; the filtration of a decoction while hot would be therefore the moſt proper kind of clarification.

XCIII. OF EXTRACTS.

§ DCCXIX. If the decoction of a plant be again expoſed to heat, its water will be gradually ſeparated in the ſtate of vapours; the fixed particles extracted from the plant will remain; and, at length, a maſs, more or leſs black, conſiſtent, and nearly dry, termed an aqueous or gummy extract is obtained. In this, all the parts of the plant diſſolved in the water are thus obtained pure and free from water.

§ DCCXX. Extracts may be prepared in the ſame manner from freſh expreſſed juices of plants, the juices of fruits, and from liquids obtained by the inciſion of vegetables. Theſe extracts differ from the former, ſince they not only contain thoſe principles of the plant which are ſoluble in water, but alſo ſuch ſolid parts as are ſeparated by preſſure.

§ DCCXXI. The end which we propoſe ourſelves in the preparation of extracts for medical purpoſes is, 1, that we may have in a ſmall compaſs a conſiderable portion of the active fixed principles of vegetables; 2, that we may poſſeſs them in a form under which they may be preſerved for a long time without undergoing any alteration, and be alſo commodiouſly ſent from place to place; and under which, 3, they may be exhibited to the patient, both in a dry ſtate and in a ſtate of mixture with liquid bodies. It is obvious that ſuch plants alone afford good extracts, of which the virtues are owing to the fixed parts.

§ DCCXXII. That extracts may be properly prepared for medical purpoſes, it is requiſite therefore:

1. That ambuſtion be prevented as much as poſſible; for, if the virtue of the extract be not thus deſtroyed or diminiſhed, it at leaſt acquires an ungrateful taſte and ſmell. This is effected by its being continually ſtirred, and by cauſing the final evaporation of the decoction to take place on a water-bath.

2. The evaporation ought to be effected by a moderate heat, that too rapid ebullition may be thus avoided; for we ought to conſider that the maſs towards the end of the operation requires a much higher temperature to boil than the pure water; and that, on account of this extraordinary heat, not only many fixed parts may be carried away by the vapours of the water, but that the extract itſelf may undergo an eſſential change.

3. Since extracts contain alſo the ſaline parts of plants, they are by no means to be kept in metallic veſſels, eſpecially thoſe of copper, braſs, or lead.—Common extracts may be, indeed, made in braſs veſſels, but ſhould not be ſuffered to cool in them.—Neither ſhould the juices of pears or other fruits be condenſed in veſſels of this kind.

4. The decoctions, of which extracts are to be made, require no other purification than filtration while hot.

§ DCCXXIII. Extracts, according to their degree of conſiſtence, are divided into dry and ſoft; and, with regard to the materials employed, into ſimple and compound. Soft extracts have the conſiſtence of honey, and are to be preferred to dry ones, on account of their virtue and ſolubility. But the latter, which do not adhere to the fingers when handled, may be preſerved for a longer time.

XCIV. OF FECULA.

§ DCCXXIV. If the parts of a freſh plant be bruiſed, or pounded, and then preſſed, they afford a juice which ſucceſſively depoſits more or leſs of a powder, inſoluble in water, termed fecula. This ſubſtance is obtained ſtill better, and more eaſily, if cold water be poured upon the bruiſed plant, and this expreſſed infuſion ſuffered to remain at reſt.

§ DCCXXV. Plants in general yield but a ſmall quantity of fecula; but farinaceous roots and ſeeds contain it in abundance. It is chiefly prepared from the potatoe, bryony, piony, and others. The moſt common of all is the ſtarch and hair-powder obtained from wheat.

§ DCCXXVI. As the ſolid parts of vegetables differ in their properties from the fluid, ſo fecula differs, in its medicinal virtues, from thoſe of the parts of the plant from which it is prepared. Thus, from the penetrating herb wake-robin, an inſipid fecula is obtained; and from the baneful bryony, a harmleſs fecula. All theſe fecula agree, in general, in their common properties; but, ſince none has been ſo attentively examined as ſtarch, and that part of the plant from which it is obtained, the conſideration of theſe may be ſufficient from the preſent.

§ DCCXXVII. Farina, or flour, as it is commonly termed, is a dry, friable, inſipid ſubſtance, obtained by grinding wheat, barley, oats, rice, &c. The farina obtained from each of theſe grains may be readily ſeparated into three conſtituent parts, which wheat contains in the moſt equal proportion. For this purpoſe, flour of wheat is kneaded into a paſte, or dough, with water, which, being encloſed in a linen cloth, and compreſſed in cold water by the hand till the water is no longer tinged, there remains a greyiſh viſcid maſs, called the gluten of farina, or vegeto-animal matter. The water employed depoſits a ſediment, which is the ſtarch; and the evaporation of the water, after this depoſition, affords a browniſh liquid, like ſyrup, viz. the ſaccharine matter of flour.

§ DCCXXVIII. The glutinous part of flour is a white, greyiſh, tenacious matter, which dries in the air into a horny maſs. It is inſoluble both in water and ſpirit of wine; and, if boiled with the former, it coagulates like the white of egg. It burns like horn, and affords the ſame products by diſtillation in the dry way. It readily putrefies, when kept in a cold and moiſt place. It is ſoluble, when freſh, in the acetic acid.

§ DCCXXIX. Starch is not ſoluble in cold water: with hot water it forms a ſemi-tranſparent gelatinous maſs, commonly termed gluten. This ſubſtance, when dried in the open air, or by the fire, becomes a horny maſs, which is again diſſolved in hot water. If kept in damp places, it undergoes in a ſhort time the acid fermentation. In general, ſtarch agrees in its chemical properties with the gummy and mucilaginous parts of vegetables, with which it alſo yields the ſame products by diſtillation in the dry way.

§ DCCXXX. That ſmall quantity of browniſh matter, which is obtained from the evaporated water of the ablution, after the ſeparation of the ſtarch, poſſeſſes all the chemical properties of ſugar, and, like this, firſt undergoes the vinous, and afterwards the acid fermentation.

§ DCCXXXI. It is theſe three conſtituents of farina which, from their tendency to the three known fermentations, ſeem to produce in flour, when kneaded, that peculiar ferment which is altogether ſo neceſſary to the making of bread; and that particular proportion of theſe conſtituents in the flour of wheat renders it the moſt proper for the making of good bread.

XCV. OF DISTILLED WATERS.

§ DCCXXXII. Since the volatile parts of a plant are not ſufficiently arreſted by the water which it affords by ſpontaneous diſtillation, (§ DCC.) ſo, as to be preſerved in that ſtate, we, therefore, to accompliſh this end, have recourſe to the following method, by which we obtain what is termed medicinal diſtilled waters. A copper veſſel, well tinned, is half filled with the freſh plant, and to two-thirds with common water. Having applied an alembic, and a refrigeratory tub, with a worm, the diſtillation is commenced, and continued by a moderate heat, as long as the water, which comes over, exhibits the ſlighteſt ſmell. If the quantity of the plant be but ſmall, the operation may be performed in a cucurbit with an alembic of glaſs.

§ DCCXXXIII. This operation is ſtrictly a decoction in cloſed veſſels. The aroma and the etherial oil, diſſolved in the water by means of the former, together with a part of the additional water in the ſtate of vapour, paſs into the receiver, and form the medicinal diſtilled water, which is named according to the plant made uſe of; as aqua minthæ, aqua ſalviæ, &c.

§ DCCXXXIV. Hence it is obvious, that good diſtilled waters can be prepared of ſuch plants alone which evidently contain aroma and etherial oil; and that thoſe, whoſe medicinal virtues are inherent in the fixed parts, for inſtance, plants which are ſimply ſweet, bitter, acerb, nutritive, emollient, &c. afford inefficacious and inodorous diſtilled waters. There are ſome plants whoſe narcotic or cathartic qualities paſs into the diſtilled waters; but in ſo ſmall a proportion as not to be worth the trouble.

§ DCCXXXV. The aroma in theſe diſtilled waters is arreſted by the etherial oil; whence it is not ſo eaſily diſſipated. It is for this reaſon, likewiſe, that the diſtilled waters, afforded by plants which do not poſſeſs any etherial oil, are ſpeedily deprived of all their odour, nay, are frequently entirely deſtitute of it.

§ DCCXXXVI. The quantity of etherial oil is ſo great in many diſtilled waters as not to be maintained in ſolution; conſequently, by its mechanical diffuſion it renders the water turbid, till it collects at the ſurface or bottom, when the water becomes again clear. Some diſtilled waters may be alſo, when freſh, quite limpid, yet become turbid from age, in conſequence of the eſcape of that aroma which was required for the union of the oil and water. Laſtly, recent diſtilled waters may be turbid, and remain ſo for years; but this ſeems to depend upon other cauſes than the oil.

§ DCCXXXVII. Every diſtilled water has its proper point of ſaturation, which experience and a knowledge of the plants will determine. They may be either too weak or too ſtrong. The former fault is rectified by cohobation, when the water is re-diſtilled upon a freſh quantity of the ſame plant. Dilution with pure diſtilled water corrects the latter.

§ DCCXXXVIII. To prepare diſtilled waters properly, the following cautions muſt be uſed:

1. The veſſel is not to be too much filled with herbs; for in ſuch caſe, they might be carried by the force of ebullition into the alembic, and thus diſturb the operation.

2. All the joinings of the apparatus ſhould be carefully cloſed with paſte and paper, to prevent a loſs of vapours.

3. But the joining between the beak of the worm and the receiver is not to be cloſed till the water becomes hot, in order that the air, diſengaged from the plants, may find vent.

4. The water in the refrigeratory-tub ſhould be always cool, ſo that the diſtilled water may be ſufficiently cool when it paſſes into the receiver; for otherwiſe the aroma will in a great meaſure eſcape.

5. The operation ought to be diſcontinued as ſoon as the water ceaſes to poſſeſs the odour of the plant; for the water, being now entirely deſtitute of virtue, would only too much dilute and weaken the effiacious water obtained firſt. In turbid water, the end of the operation is indicated by its limpidity. But ſkilful operators determine this period from the quantity of the herbs made uſe of, and from the quantity of water obtained.

6. At the commencement of the diſtillation, a ſufficient quantity of water is to be affuſed, leſt the plants dry and burn, whereby an ungrateful odour might be communicated to the diſtilled water, along with a ſmall portion of empyreumatic acid.

7. The veſſel, and eſpecially the alembic, ſhould be well tinned, to prevent the formation of verdigris.

§ DCCXXXIX. Diſtilled waters are to be kept in cool and dry cellars, in glaſs or earthen veſſels, kept moderately cloſe, by corks and paper. But thoſe for daily uſe in the laboratory ſhould be contained in glaſs bottles well corked; and here we ought to be careful not to let the etherial oil ſwim upon the ſurface, leſt it enter the mixtures.

§ DCCXL. The parts of vegetables of a harder texture, or which greatly abound in etherial oil, are previous to diſtillation to be macerated, for ſome hours, in the veſſel, that the water may take up a greater quantity of the volatile parts. In this maceration ſome recommend an addition of ſalts, which, though they produce no harm, cannot do much good.

XCVI. OF ETHERIAL OR VOLATILE OILS.

§ DCCXLI. If diſtilled water contain more etherial oil than it can hold in ſolution, the oil is collected in a particular ſtratum, either on the ſurface, or at the bottom of the water. That this oil may be thus acquired in greater abundance, diſtilled water is cohobated ſeveral times upon recent plants, and a ſtrong fire is applied at the beginning of the operation, that time may not be allowed for the oil to be diſſolved in the water.

§ DCCXLII. In other reſpects this operation requires the ſame treatment and cautions as the diſtillation of the waters already mentioned. Oils are ſeparated from water in three ways:

1. By a ſilver ſpoon.
2. By a glaſs funnel.
3. By a cotton wick, through which the oil permeates into a phial, attached to the neck of the receiver. Since all foreign matter remains in the water, when this method is employed, we juſtly prefer it to any other.

Oils which exceed water in ſpecific gravity are either ſeparated by the ſecond method, or the water is rendered heavier than the oil by a ſolution of common ſalt; ſo that the oil floats on the ſurface, when the remaining two methods may be employed.

§ DCCXLIII. Etherial, volatile, or eſſential oils are all volatile at the temperature of boiling water;

but, for the moſt part, they eſcape even under the common temperature of the atmoſphere. In this temperature ſome few are conſtantly congealed, and require a higher temperature for liquifaction. They all become thick in the open air, and are at length changed into a reſinous maſs, when ſome depoſit an acid ſalt, others camphor.

§ DCCXLIV. Etherial oils differ greatly in colour; ſome are pale, others yellow, brown, or red, nay blue or green. Beſides, the colour of an eſſential oil, of one and the ſame plant, is frequently different according to the ſeaſon, the age of the plant, and the degree of heat applied in the diſtillation, &c. The age of the oil has alſo an effect upon its colour.

§ DCCXLV. Etherial oils, ſuch, for inſtance, as are prepared of European plants, are for the moſt part ſpecifically lighter than water, and therefore float upon its ſurface. Some few are heavier, which fall to the bottom; ſuch as oils extracted from the aromatic plants of both the Indies. Many oils are very thin and liquid, but ſome, even when recently prepared, are thick and mucilaginous; ſo that during the diſtillation they every where adhere to the beak of the alembic and to the worm, as the oil of the millefolium. But this ſpiſſitude of oils has no influence upon their ſpecific gravity.

§ DCCXLVI. Etherial oils always poſſeſs the odour of the plant from which they are obtained.

They are remarkable for an acrid and burning taſte; but this acrimony is not always proportioned to the acrimony of the plant; thus the oil of mugwort and dragonwort is but acrid in a very ſlight degree compared with the plants themſelves.

§ DCCXLVII. Some authors inſiſt that more eſſential oil is to be obtained from dried than recent plants. But ſuppoſing this not to be the caſe, it is certain that dry plants afford a purer and more attenuated oil.

§ DCCXLVIII. Etherial oils are true extracts, and exiſt in the plant in the ſame ſtate in which we obtain them; which is eaſily proved, ſince from ſome parts of vegetables the etherial oil may be obtained by preſſure alone, as from orange and lemon peel.

§ DCCXLIX. As etherial oils are always at a high price, they are likely to be adulterated, which may be effected:

1. By expreſſed oils.
2. By ſpirit of wine.
3. By inferior etherial oils.

The firſt fraud is diſcovered when paper, ſtained with the oil to be examined, leaves, on expoſure to fire, a tranſparent ſpot; for, if the oil be genuine, it will entirely diſappear. Or a ſmall portion of it is dropped upon ſpirit of wine, which diſſolves the etherial oil, and leaves that which is expreſſed.

We diſcover the ſecond fraud if a drop of the oil falls from ſome height into water, when it leaves a milky veſtige, if adulterated.

The third fraud is known from the ſmell which linen, ſtained with this oil, diffuſes when quickly burnt; for the adulteration is for the moſt part effected by means of oil of turpentine.

XCVII. OF FAT OR FIXED OILS.

§ DCCL. Some parts of plants contain another kind of oil, equally free, yet very different from etherial oil. Such parts are eſpecially the ſeeds, as almonds, nuts, linſeed, hemp, &c. from which we obtain it ſimply by preſſing the bruiſed ſeed between a cloth. It is probable that this oil forms one of the conſtituents of all plants, but, that in moſt of them it is ſo intimately connected with the other reſinous and mucilaginous principles, as not to be readily ſeparated.

§ DCCLI. Theſe fat or expreſſed oils differ from etherial oils in as much as they are deſtitute of odour, mild to the taſte, unchangeable and fixed at a higher temperature, and being ſooner decompoſed than evaporated; and, laſtly, becauſe they are inſoluble in water and ſpirit of wine.

§ DCCLII. Moſt fat oils are liquid at the common temperature of the atmoſphere, and do not congeal unleſs the temperature be diminiſhed. Some few however are always ſeen in this congealed ſtate, as the oil of bay-berries and cocoa-ſeed, which laſt is, on this account, named butter of cocoa. As theſe oils are not readily obtained by preſſure alone, the bruiſed ſeed is boiled for ſome time in water, when the oil is ſeparated, and, being cooled, floats upon the ſurface.

§ DCCLIII. The quantity of oil obtained is greater, if, previous to expreſſion or coction, the ſeed or berries be gently torrefied, becauſe their mucilaginous parts are thus deſtroyed. But as it is in fact this mucilage which tends, in a great meaſure, to render the oil mild, therefore, oils obtained as above, are leſs mild and more diluted. But here, alſo, combuſtion of the ſeed is as much as poſſible to be avoided, leſt the oils obtain an empyreumatic odour. Oils, ſeparated from torrefied ſeeds, are alſo ſaid to become ſooner rancid.

§ DCCLIV. Fat oils, when kept for a long time, corrupt, and become rancid; their acid is diſengaged, and communicates an acrid taſte and penetrating ſmell. This corruption of oils happens in a greater or leſs ſpace of time, and is, for the moſt part, in an inverſe ratio of the temperature required for their congelation. But if ſuch oils be ſpread very thinly and expoſed to the air, they attract the oxygen from it, and change into a maſs ſimilar to wax. The ſame effect is more ſpeedily produced by acids, and eſpecially by the oxygenated muriatic acid. By trituration alone, with the concentrated ſulphuric acid, they form the acid ſoap.

§ DCCLV. Fat oils, when heated to the point of ebullition, become inſpiſſated; but this effect is produced much more ſpeedily, if they be boiled with metallic oxides; for, by depriving them of a portion of their oxygen, they become thicker. From linſeed-oil and the calx of lead we obtain, in this manner, what is termed oil-varniſh, which dries more readily, and is, therefore, made uſe of for colours.

§ DCCLVI. Fat oils do not act upon earths; but they combine with alkaline ſalts, with which, when cauſtic, they form vegetable-ſoaps. For this purpoſe a cauſtic alkaline ley is boiled for ſome time with fat oils. Theſe ſoaps are ſoluble in water, and decompoundable by acids, which ſeparate the oil. The ſoap prepared with ſoda is dry, but that with pot-aſh deliqueſces in atmoſpheric air. Ammoniacal ſoap is only to be formed by a long continued trituration.

§ DCCLVII. Etherial, as well as fat oils, aided by heat, readily diſſolve ſulphur, with which they form an inſpiſſated brown liquor. If twelve parts of fat oil be melted with one part of ſulphur, in a glazed earthen veſſel, the maſs thus produced is termed Ruland's balſam of ſulphur. It ſwells conſiderably during this operation, and frequently inflames, which, however, may be prevented by a proper attention to the fire. In the ſame manner we prepare balſams of ſulphur with etherial oils; but theſe ſubſtances are even more apt to inflame than the former, and frequently produce a dangerous exploſion.

§ DCCLVIII. If ſeeds, abounding in fat oil, be bruiſed in a mortar, with a little additional water, we obtain, by expreſſing the maſs, a white liquor, like milk, called an emulſion. Bruiſing is a continued preſſure whereby the fat oil is ſeparated from the ſeed, and remains diſſolved for ſome time in the water by the aid of the farinaceous and mucilaginous parts, extracted at the ſame time.

§ DCCLIX. Nevertheleſs, the union of the conſtituent parts in an emulſion is weak, and the oil, as well as the farinaceous parts are gradually ſeparated from the water; by agitation, however, they are again taken up. An emulſion readily ferments, on account of the mucilage; and this frequently happens during the hot days of ſummer in the ſpace of a few hours. It alſo becomes rancid on account of the fat oil.

XCVIII. OF WAX, RESINS, BALSAMS, AND GUMS.

§ DCCLX. Wax, in regard to its properties, agrees, for the moſt part, with pure fat oils, and exhibits the ſame phenomena, both in the fire and in its combinations. It is naturally white, and acquires a yellow colour from honey alone, of which it may be again deprived by bleaching in the air, as well as by the oxygenated muriatic acid. It is then called virgin or white wax.

§ DCCLXI. Common wax is collected by bees from the flowers of plants; but there are alſo ſome parts of plants which abound ſo much in wax, that it may be extracted from them ſimply by decoction. Such is the green wax afforded by the Myrica cerifera, which approaches ſtill more to the nature of fat oils. In the Weſt Indies there is a ſpecies of bees which furniſh black wax that cannot be whitened by bleaching.

§ DCCLXII. Gum is the inſpiſſated juice of plants, which exudes from them either ſpontaneouſly, or by making inciſions in the bark. It is generally white, or ſomewhat yellow, ſeldom brown or red. It is ſoluble in water with which it forms mucilage. But it is inſoluble in alcohol, ether, etherial and fat oils. The mucilage and ſtarch, obtained by decoction from various other plants, for inſtance, the root of the Marſhmallow and the kernels of Quinces, &c. does not differ in its chemical properties from a ſolution of gum in water.

§ DCCLXIII. Reſins are obtained from vegetables in the ſame manner as gums. They are inflammable, and, when inflamed, diffuſe a ſtrong and peculiar odour. They are perfectly ſoluble in alcohol, with which they form tinctures, eſſences, and elixirs. The reſinous parts may be extracted from almoſt every plant, by means of alcohol; and tinctures are thus prepared which yield all their reſin on the addition of water, for which reaſon they are termed ſpirituous extracts. Reſins are alſo ſoluble in fat and etherial oils; with the latter they form varniſhes, and, with the former, artificial balſams. Etherial oil may be obtained from ſome reſins by diſtillation with water.

§ DCCLXIV. Balſams merely differ from reſins in fluidity, and in containing more etherial oil;

whence they poſſeſs a ſtronger ſmell and ſome taſte. All native reſins were originally balſams; and, therefore, all balſams may be converted into reſins by the artificial ſeparation of their etherial oil.

§ DCCLXV. Gum-reſins are native, inſpiſſated, vegetable juices, compoſed of gum and reſin. They are formed by art, when, after the parts of plants have been digeſted in diluted alcohol, the alcohol is evaporated. For this reaſon moſt tinctures contain gum-reſin.

§ DCCLXVI. Elaſtic gum, or Caoutchouc, which is the inſpiſſated juice of the Iatropha elaſtica, a Weſt-Indian plant, is very different from the bodies abovementioned. It is neither ſoluble in water nor in alcohol, and but in a ſlight degree in fat oils; but it is entirely diſſolved in ether and naphtha. It melts on expoſure to fire into an unctuous maſs, which cannot be again rendered ſolid. Its natural colour is white, inclining to yellow, but is blackened artificially by ſmoke. The expreſſed and inſpiſſated juice of miſtle-berries agrees, in ſome reſpects, with this ſubſtance.

XCIX. OF CAMPHOR.

§ DCCLXVII. Camphor is a peculiar body, which forms a conſtituent part of many odoriferous plants; but moſt of theſe contain it in ſmall quantity only, and it is generally obtained by ſpontaneous ſeparation from their etherial oils. The Laurus camphora, Laurus cinnamomum, and the camphor-tree of Surinam, contain it in ſuch abundance, that it not only exudes from the trunk, branches, and roots, but may be alſo extracted from them by ſublimation. That which is ſold in Europe is altogether obtained from the Laurus Camphoræ of Japan.

§ DCCLXVIII. Camphor is of a white colour, and cryſtalline texture. It is diſtinguiſhed by a peculiar and ſtrong ſmell. It evaporates at the common temperature of the atmoſphere, without leaving the ſmalleſt veſtige behind. It is ſublimed without change in cloſe veſſels. It is ſpecifically lighter than water, in which it is perfectly inſoluble. But it is readily diſſolved in ſpirit of wine, and in etherial and expreſſed oils.

§ DCCLXIX. It is alſo ſoluble in the mineral acids, and, if eight parts of nitric acid be diſtilled upon one part of camphor, and this operation be repeated twelve times with freſh acid, we obtain a dry acid ſalt, which is the camphoric acid. This ſalt approaches in its properties to the oxalic acid. Camphor, when mixed and diſtilled with clay, is changed into a yellow oil, the oil of camphor, not different from camphor itſelf, except in its fluidity.

C. OF SUGAR.

§ DCCLXX. Sugar is properly a white cryſtalline body, obtained from the expreſſed juice of the ſugar-cane by evaporation and refining. The ſame ſubſtance may be alſo prepared from the juice of many other plants; neither manna, nor honey, when properly purified, differ chemically from ſugar.

§ DCCLXXI. Sugar agrees, in ſome meaſure, in its general properties, with ſalts. It is remarkable for a peculiar ſweet taſte. It is diſſolved in water and ſpirit of wine, and oils are rendered ſoluble in water by its union.

§ DCCLXXII. If one part of ſugar be diſtilled with three parts of nitric acid, till nitrous gaz ceaſes to be developed, and then re-diſtilled with three parts of the ſame acid, a white cryſtallized ſalt is found in the liquid reſidue, which is the acid of ſugar. The nitric acid is here partly decompoſed; its oxygen unites with the ſugar, forming the acid of ſugar; the trous gaz is ſeparated, and the remaining nitric acid is carried over into the receiver.

§ DCCLXXIII. The acid of ſugar forms regular tetraëdral priſmatic cryſtals, which have a ſharp, acid, and not ungrateful taſte. It is perfectly diſſolved in two parts of cold water, with ſome crepitation. When expoſed to fire, in cloſed veſſels, it is partly ſublimed in the form of a white powder, and partly decompoſed and carried into the receiver as empyreumatic acid of ſugar.

§ DCCLXXIV. The acid of ſugar combines with the fixed alkalis, and forms neutral ſalts, very ſoluble in hot water, ſuſceptible of being ſuperſaturated with the acid, when they cryſtallize in a columnar form, and are decompoundable in fire, in which caſe the alkali is left in a mild ſtate. With ammoniac it produces a neutral ſalt, which ſhoots alſo into tetraëdral columns, effloreſces in the open air, and is partly decompounded by fire, and partly ſublimed.

§ DCCLXXV. Of all the alkaline baſes, lime has the greateſt affinity with the acid of ſugar. The earthy ſalt, thus formed, is almoſt inſoluble in water. Hence the pure acid of ſugar, as well as the neutral acido-ſaccharine ſalts, are excellent teſts for detecting lime. This ſalt is beſt prepared by the decompoſition of nitrate of lime by the acid of ſugar.

§ DCCLXXVI. Baryt and magneſia form earthy ſalts with the acid of ſugar, which are not ſoluble in water unleſs they be ſuperſaturated with the acid, the firſt of which may then be cryſtallized. With alumine it produces an acido-ſaccharine maſs of a yellowiſh colour, not cryſtallizable, and deliqueſcent when expoſed to the air.

§ DCCLXXVII. The acid of ſugar unites with almoſt all metals, forming metallic ſalts, difficultly ſoluble in water. The ſaccharine acid, when combined with mercury, and expoſed to fire, poſſeſſes a fulminating property.

CI. OF THE SALT OF SORREL.

§ DCCLXXVIII. Sorrel, wood ſorrel, and probably all plants poſſeſſing a genuine acid taſte, contain a ſalt which, by the evaporation of the juice and repoſe, ſhoots into cryſtals, generally termed their eſſential ſalt. To obtain it from either of the plants mentioned, the freſh juice, evaporated almoſt to the conſiſtence of honey, is poured into a glaſs bottle with a narrow neck, and covered, by pouring upon it a ſtratum of the oil of olives. After ſome weeks, the ſides of the bottle are inveſted with a cruſt, which is the ſalt of ſorrel; a greater quantity of which may be obtained from the ſame juice by a repetition of the operation.

§ DCCLXXIX. This ſalt of ſorrel is a neutral acidulous ſalt, conſiſting of pot-aſh, ſuperſaturated with a peculiar acid. It forms itſelf into ſmall lamellar cryſtals, which are ſoluble in ſix parts of boiling water, and remain unchanged in the atmoſphere. In order to decompound it, a ſmall portion of nitrate of baryt is added to its aqueous ſolution, when the baryt unites with the oxalic acid, and the pot-aſh with the nitric acid. The oxalate of baryt, which is precipitated, is afterwards decompounded by digeſtion with ſulphuric acid.

§ DCCLXXX. Formerly the oxalic acid was conſidered as an acid different from that of ſugar; but it is now proved by experiment, that it does not differ from this acid in any of its properties, and hence the terms oxalic acid and acid of ſugar are ſynonimous.

CII. OF THE BENZOIC ACID.

§ DCCLXXXI. Benzoin contains a peculiar ſalt in a free ſtate, named the benzoic acid, which may be ſeparated from it by various proceſſes, two of which are commonly employed. The benzoin is either fuſed by a gentle heat, in an earthen cucurbit, covered with an earthen or paper cone, when the ſalt ſublimes in ſmall white cryſtals, termed flowers of benzoin, which are the benzoic acid. Or, the benzoin being reduced to powder, is boiled in water with lime recently ſlaked, afterwards filtered and evaporated, and, when cooled, affuſed with the muriatic acid, by which means the benzoic acid is precipitated in the form of a white powder.

§ DCCLXXXII. The benzoic acid has a peculiar cauſtic taſte. It forms ſmall cryſtals, which glitter like ſilk, and remain unchanged under the common temperature of the atmoſphere. It is difficultly ſoluble in cold water, but more readily in hot water and ſpirit of wine. In cloſed veſſels it may be entirely ſublimed without change. On expoſure to fire, and in contact with the atmoſphere, it burns with flame and an agreeable ſmell. It is but little affected by the nitric acid.

§ DCCLXXXIII. Combined with alkalis it forms neutral ſalts in acicular cryſtals, which attract humidity from the atmoſphere, or effloreſce. With lime it forms an earthy ſalt, which is perfectly ſoluble in water, and of a ſweetiſh taſte. All theſe ſalts are decompoſed by fire.

§ DCCLXXXIV. The benzoic acid is likewiſe obtained from many other reſins and balſams, ſuch as balſams of Peru and Tolu, ſtorax, &c.

CIII. OF THE CITRIC ACID.

§ DCCLXXXV. The juice of lemons conſiſts properly of four parts; of the citric acid, the malic acid, mucilage, and water. Pure citric acid may be obtained from it in the following manner: pure chalk being thrown into pure lemon-juice, previouſly heated, the citric acid combines with the chalk, and forms an earthy neutral ſalt, inſoluble in water, whilſt another portion of the chalk is taken up by the malic acid, and remains diſſolved in the water. The precipitate is then ſeparated, and digeſted with diluted ſulphuric acid, which combines with the chalk, when pure citric acid may be obtained in cryſtals by the evaporation of the remaining lixivium.

§ DCCLXXXVI. The citric acid, when combined with alkalis, forms neutral deliqueſcent cryſtallizable ſalts, and with the alkaline earths uncryſtallizable ſalts. It differs principally from the acid of tartar, as it does not decompound muriate of pot-aſh. When boiled with the nitric acid, it is changed into acid of ſugar.

CIV. OF THE MALIC ACID.

§ DCCLXXXVII. The juice of apples contains a peculiar acid, called the malic acid, which is obtained from it by the following method: ſaturate the juice of apples with pot-aſh, filter the lixivium, and add acetate of lead till precipitation ceaſes. Having edulcorated the precipitate, it is digeſted with diluted ſulphuric acid, and the liquor decanted off is pure malic acid.

§ DCCLXXXVIII. Pure malic acid cannot be cryſtallized. When boiled with the nitric acid, it becomes acid of ſugar. With alkalis it produces deliqueſcent neutral ſalts. When completely ſaturated with lime, it forms an earthy ſalt inſoluble in water; but imperfectly ſaturated with the ſame, it forms a ſalt readily ſoluble in water.

§ DCCLXXXIX. The malic acid readily diſſolves iron, ſo that if digeſted, when freſh, on iron filings, a brown ſolution is obtained, which, when condenſed by evaporation, forms the extract of iron by the malic acid, and, combined with alcohol, the tincture of iron by the malic acid.

§ DCCXC. Many other ſour fruits, beſides apples, contain the malic acid as a conſtituent part, and always more or leſs mixed with the citric and tartareous acids; ſuch fruits are barberries, currants, ſloes, cherries, raſpberries, ſtrawberries, elderberries, brambleberries, &c. from all of which the malic acid may be obtained by the method deſcribed. (§ DCCLXXXVII.)

CV. OF THE GALLIC ACID.

§ DCCXCI. We have long been acquainted with a peculiar property of certain plants, called aſtringent; and this property was always attributed to ſome particular part of the plant, which they termed the aſtringent principle. But it has been proved by modern experiments, that this principle is of a ſaline, and probably acid, nature. The parts of vegetables which moſt abound in it are the barks of various trees, as of the oak, Peruvian bark, the leaves of tea, ſumach; but, above all, the gallnut, whence it has received the name of gallic acid.

§ DCCXCII. The acid of galls is obtained from plants, as well by means of water as ſpirit of wine; and the infuſions and tinctures, thus produced, are remarkable for a peculiar aſtringent taſte, and for exhibiting very ſingular phenomena in precipitating different metals from their ſolutions; gold and ſilver, for inſtance, are precipitated in a metallic form, whilſt the other metals aſſume various colours. But the black precipitate of iron, obtained from ſulphate of iron by the gallic acid, is that which is moſt known, and which, when united with gum, forms that uſeful liquid termed ink.

§ DCCXCIII. All theſe precipitates may be conſidered as metallic ſalts. They are ſoluble again in mineral acids, but not acted upon by vegetable acids; vinegar, therefore, is added to common ink to defend it againſt mouldineſs.

§ DCCXCIV. To obtain pure gallic acid, eight parts of cold water are poured upon galls, reduced to powder. This infuſion is ſuffered to reſt for ſome days, when the yellowiſh liquor is decanted off, and kept in a warm place. After ſome months, it deposits a brown matter, upon which alcohol being affuſed, the tincture is evaporated to dryneſs, when it affords ſmall cryſtals, which conſtitute the gallic acid.

§ DCCXCV. This acid has a ſour taſte. It reddens the tincture of turnſole, and efferveſces with mild alkalis. It is perfectly diſſolved in one and a half part of water and four of alcohol. When diſtilled to dryneſs, in cloſe veſſels, it affords an acidulous phlegm, and a dry ſublimed ſalt, ſimilar, in appearance, to the benzoic acid, but poſſeſſing the properties of the gallic acid. When boiled with the nitric acid, it is almoſt entirely changed into acid of ſugar.

CVI. OF OTHER NATIVE VEGETABLE-SALTS.

§ DCCXCVI. Beſides the ſalts already mentioned, almoſt every plant contains ſome portion of fixed alkali, which may be ſeparated from it by digeſtion with acids. It is alſo not unfrequently the caſe, that ſome plants contain, accidentally, neutral, earthy, and metallic ſalts, as nitre in the heliotrope, tobacco, and others; common ſalt in plants growing contiguous to the ſea; ſulphate of pot-aſh in the millefolium, and ſome aromatic plants; ſal mirabilis in the tamariſk, &c.

CVII. CONCERNING THE EFFECTS OF A HIGHER TEMPERATURE UPON PLANTS AND THEIR COMPONENT PARTS.

§ DCCXCVII. All the experiments hitherto made have taught us that plants are affected in two ways, with regard to the change which they undergo when expoſed to a ſtronger fire; for which reaſon they were divided by Boerhaave into two claſſes. To inveſtigate the nature of plants in this way, they are introduced into a glaſs retort, without the addition of any other ſubſtance; the fire is then gradually increaſed, till the retort becomes red hot, and the products, afforded at different temperatures, are ſeparately collected.

§ DCCXCVIII. The plants of the firſt claſs afford, by theſe means:

1. Their native water, impregnated, according to circumſtances, with aroma and etherial oil.

2. A brown empyreumatic acid phlegm, which grows darker, and ultimately black.

3. An inſpiſſated, black, empyreumatic oil; latterly alſo a conſiderable quantity of hydrogen and carbonic acid gaz; and, towards the concluſion, the fire being conſiderable increaſed, a ſmall portion of carbonate of ammoniac. In the retort there remains pure charcoal only.

§ DCCXCIX. The liquid obtained firſt is the native water of the plant, (§ DCC.) except that not unfrequently it is rendered impure by part of the ſucceeding products. The other product is a true acid; but this did not exiſt in the plant ſuch as we obtain it, becauſe it owes its formation to the mucilaginous and oily parts burnt in this increaſed temperature, and acidified, in ſome meaſure, by the oxygen of the native water of the plant. This acid, which is obtained in greater abundance from the harder parts of plants, as from wood, is termed, by modern Chemiſts, the pyroligneous acid. Its burnt ſmell is chiefly owing to the empyreumatic oil with which it is united, and from which, in ſome meaſure, it may be purified by repeated diſtillation.

§ DCCC. The empyreumatic oil, which comes over with the laſt portion of empyreumatic acid, is unqueſtionably produced during the operation, and probably differs from etherial oils only on account of a greater quantity of carbon which it obtains during its mixture. By repeated diſtillation, without any additional body, the colour of ſuch empyreumatic oils becomes fainter; they yield a ſmall portion of acid, depoſit ſome carbon, and are then perfectly ſoluble in ſpirit of wine.

§ DCCCI. The carbonate of ammoniac, obtained towards the end of the operation, when the heat became intenſe, is a mere product; for all the conſtituent principles of carbonic acid and ammoniac preexiſt in the plants, and only become capable of chemically uniting at this particular temperature.

§ DCCCII. The reſidue in this operation is a black matter, commonly termed charcoal. This body ſuffers no farther decompoſition in cloſed veſſels, although urged by the ſtrongeſt fire. But, in contact with the atmoſphere, it burns with a white flame; nearly three-fourths of it unite with the oxygen, and form carbonic acid, whilſt pot-aſh or ſoda, lime and metallic particles remain. This reſidue is called vegetable-aſhes.

§ DCCCIII. All the parts of plants of the firſt claſs, as alſo their aqueous extracts, exhibit the ſame effects from this treatment, except that the latter afford a ſmaller portion of water, more empyreumatic acid and oil, and a coal, which, when burnt, yields much alkaline ſalt, and but little earth. But, if the plant be previouſly deprived of its juices by repeated coction, and then diſtilled, it will furniſh but little acid or oil, and charcoal, which, by incineration, affords no pot-aſh, but merely a ſmall portion of earth, and a few metallic particles.

§ DCCCIV. The aſhes obtained from the combuſtion of common vegetable charcoal, or of the recent plant itſelf, in a naked fire, conſiſt of ſaline, earthy, and metallic particles; but which are not always of the ſame kind, nor in the ſame proportion. The ſaline parts are readily ſeparated by ſolution in water, filtration, and evaporation.

§ DCCCV. From this habitude of extracts and excocted plants, by dry diſtillation, we may infer:

1. That empyreumatic oils and acids, as well as pot-aſh, derive, in a great meaſure, their origin from parts of plants diſſolved in water.

2. That common charcoal conſiſts of a peculiar ſubſtance, combined with pot-aſh, earth, and metallic particles.

3. That this ſubſtance, which has not hitherto been decompoſed, and which conſtitutes the baſis of the carbonic acid, has pre-exiſted in the plant, and is a mere product, which we call carbon.

§ DCCCVI. The aſhes of all plants, growing at a diſtance from ſalt waters, afford pot-aſh; but ſuch as grow near the ſea, or on the banks of ſalt lakes, afford ſoda. If, however, theſe ſame plants be cultivated in the interior of the country, they produce pot-aſh only. The greater part of the ſoda and pot-aſh of commerce is obtained, by the preceding method, from the aſhes of plants.

§ DCCCVII. But ſuch ſoda or pot-aſh is not pure; it in general contains more or leſs ſulphate of pot-aſh, ſulphate of ſoda, muriate of ſoda, &c. To ſeparate theſe ſalts, diſſolve the pot-aſh or ſoda in water, filter the ſolution, and evaporate it as much as neceſſary; it being then cooled, the neutral ſalts cryſtallize, and the alkali, almoſt pure, remains in the lixivium.

§ DCCCVIII. The aſhes of plants do not indiſcriminately contain the ſame quantity of ſalt, the more compact and firmer parts, as hard woods, afford much more than ſuch as are tender; although there are ſome among them which are ſcarcely inferior to the woods, as fern, wormwood, &c. Common pot-aſh, provided it be well purified, is always the ſame ſalt, from whatever plant it may be prepared; whence it is manifeſt of what trivial importance ſuch pot-aſhes are which were formerly prepared from the aſhes of different plants, and uſed in pharmacopeias under the falſe but pompous title of eſſential ſalts.

§ DCCCIX. Among theſe eſſential ſalts, as they are termed, there was one prepared in the following manner: the plants were burnt in an iron veſſel, with the cover ſlightly cloſed, and the aſhes, thus obtained, were then removed and waſhed. They denominated theſe ſalts Sales Tacheniani, from their inventor. As the combuſtion of the plant was never perfect, the ſalts contained a ſmall portion of empyreumatic oil, and appeared never perfectly white. Some Chemiſts inſiſted that, if the aſhes were calcined in a crucible previous to lixiviation, the ſalt obtained would be pure pot-aſh only.

§ DCCCX. There are alſo, for medical purpoſes, what are termed eſſential ſalts prepared with ſulphur. Theſe are formed by melting equal quantities of the flowers of ſulphur and of an eſſential ſalt in a crucible, and kept ſtrongly ignited for the ſpace of ſome hours. The maſs is then diſſolved in water, ſtrained, evaporated, and cryſtallized. As during this operation the ſulphur is entirely burnt, we may readily conclude, that this eſſential ſalt, prepared with ſulphur, is nothing but mere ſulphate of pot-aſh, or, as it is commonly termed, arcanum duplicatum. The pharmaceutic Chemiſt, however, ſhould be careful, leſt, from a want of attention, he change theſe two eſſential ſalts.

§ DCCCXI. When all the ſalts are obtained from the aſhes by waſhing, there remains a powder, which conſiſts of lime, and ſometimes a little gypſum, a very ſmall portion of iron in a metallic ſtate, and oxide of manganeſe.

§ DCCCXII. If thoſe plants, which Boerhaave places in his ſecond claſs, be treated in the ſame manner, without any additional ſubſtances, by dry diſtillation, as above-mentioned, they afford:

1. The native water of the plant, which, in general, poſſeſſes a fetid ſmell.
2. A very fetid empyreumatic oil.
3. Carbonate of ammoniac, both in a dry and liquid form.

The reſidue, in the retort, is a half melted coal, the aſhes of which contain no ſalt, but earth and metallic particles alone.

§ DCCCXIII. The formation of theſe products can only be accounted for in the ſame manner as in plants of the firſt claſs. That no fixed alkaline ſalt, but volatile alkali alone, is here produced, depends probably upon the different relation between the conſtituent parts of the plants of theſe two claſſes. The charcoal of the plants of this claſs is much more difficultly reduced to aſhes than that of the former, and, in this reſpect, approaches nearer to animal charcoal.

§ DCCCXIV. Moſt plants with which we are acquainted belong to the firſt claſs. The other claſs comprehends chiefly all thoſe acrid plants, whoſe odour excites ſneezing or tears. Of this kind are tobacco, ſneezewort, garlick, onions, muſtard, horſeradiſh, and the whole claſs of cruciform plants, except the Crambe Tataria, which is included in the firſt claſs, and the mulberry, which belongs to the ſecond.

CVIII. OF THE PARTICULAR EFFECT OF A HIGHER TEMPERATURE UPON SOME OF THE PARTS OF VEGETABLES.

§ DCCCXV. Etherial, as well as fat oils, when diſtilled per ſe, by a ſtrong heat, afford hydrogen and carbonic acid gaz, ſome empyreumatic acid, an empyreumatic oil, and a coal, which, incinerated, produces no ſalts, but earth alone.

§ DCCCXVI. If an oil be burnt in a cloſed veſſel, containing oxygen gaz or atmoſpheric air, the products are merely water and carbonic acid, and in various proportions, according to the difference of the oil. Oils, therefore, appear to conſiſt of hydrogen, carbonic acid, and a ſmall portion of earth; all of which are contained in different proportions in different oils.

§ DCCCXVII. Wax, which is ſo analogous to fat oils in its chemical properties, gives the ſame products by combuſtion and dry diſtillation. On the diſtillation of wax, per ſe, there paſſes into the receiver a fetid butyraceous maſs, called the butter of wax, and ſome acid; a ſmall portion of charcoal remains behind. This butter affords, by re-diſtillation, a ſmall portion of acid, a liquid oil, commonly termed the oil of wax, and ſome charcoal.

§ DCCCXVIII. Gums, mucilages, and the ſaccharine ſubſtances of vegetables, afford the ſame products as plants of the firſt claſs, except that their empyreumatic acid differs ſomewhat from the pyroligneous acid; whence it has obtained the name of pyro-mucous acid. The coal of theſe bodies is commonly very ſpongy and ſhining, and yields no alkaline ſalts, but pure lime and phoſphate of lime only. The pyro-mucous acid may be purified by re-diſtillation, either per ſe, or with the addition of pure clay.

§ DCCCXIX. The products of reſins, as alſo of elaſtic gum, by dry diſtillation, agree with thoſe of plants of the firſt claſs, the native water excepted. The odour of their empyreumatic oils is alſo leſs ungrateful, and the ſmell of ſome is even agreeable, as oil of benzoin. Beſides, they leave but little coaly matter, eſpecially if pure, and the aſhes of the coal contain alkali.

§ DCCCXX. Balſams, after having at the firſt degree of heat diſengaged their etherial oil, furniſh the ſame products as reſins.

§ DCCCXXI. The products of gum-reſins are compoſed of the products of gums and reſins.

§ DCCCXXII. The gluten of farina affords, by dry diſtillation, the products of the plants of the ſecond claſs; but the whole of the farina affords the products of the firſt claſs, except that the empyreumatic acid is here in part combined with ammoniac.

§ DCCCXXIII. Soot is that ſubſtance which is elevated in the form of ſmoke during the combuſtion of vegetables, and which could not be entirely burnt for want of time. This body, when diſtilled in the dry way, gives the products of plants of the ſecond claſs.

CIX. GENERAL CONSIDERATION OF THE REMOTER PRINCIPLES OF PLANTS.

§ DCCCXXIV. Though analyſis has not yet furniſhed us with an accurate knowledge of the ultimate principles of plants, yet, from the above-mentioned facts, and from general obſervation, it appears, that all vegetable bodies may be reſolved, by combuſtion, into carbonic acid, water, ammoniac, alkaline ſalts, earths, iron, and manganeſe; and that the following may be conſidered as the general and ultimate principles of plants: 1, oxygen; 2, hydrogen; 3, nitrogen; 4, carbon; 5, lime; 6, iron; 7, manganeſe.

§ DCCCXXV. Theſe ſimple ſubſtances, combined in various proportions, conſtitute, according to Mr. Lavoiſier, all vegetable-bodies. Thus oils conſiſt of hydrogen and carbon, which bodies being combined in different proportions with nitrogen, and a ſmall portion of oxygen, form the ſaccharine ſubſtances, gums, mucilages, &c. which Lavoiſier conſiders as true oxides. If more oxygen be preſent, they become various vegetable acids.

CX. OF FERMENTATION IN GENERAL.

§ DCCCXXVI. That change which under certain circumſtances the parts of vegetables ſpontaneouſly undergo, and without any degree of artificial heat, and by which their chemical properties are greatly altered, is termed fermentation, which, according to the difference of its products, is divided into three ſpecies, viz. into the ſpirituous fermentation, whereby alcohol is produced; into the acid fermentation, which forms radical vinegar; and into the putrid fermentation, which generates ammoniac.

CXI. OF THE SPIRITUOUS FERMENTATION.

§ DCCCXXVII. Not all the parts of plants are adapted for ſpirituous fermentation, but ſuch only which poſſeſs ſaccharine matter, or mucilage, in greater quantity. The other conditions requiſite for this fermentation are:

1. A certain degree of liquidity; for, if the juices of plants be either too fluid or too thick, their fermentation becomes difficult.

2. A temperature of about 15 degrees.

3. A maſs ſomewhat conſiderable, for the proceſs does not proceed ſo well when the quantity to be fermented is but ſmall.

4. The preſence of atmoſpheric air, at leaſt to a certain degree.

§ DCCCXXVIII. If the freſh juices of vegetables begin to ferment, under theſe circumſtances, an inteſtine motion is obſerved, which conſtantly increaſes until the proceſs has arrived at its higheſt pitch. At the ſame time the liquor is proportionably expanded, and its temperature ſpontaneouſly raiſed to about 20°. The liquor then becomes turbid, and evolves a conſiderable quantity of carbonic acid gaz, which, if undiſturbed, reſts as a diſtinct ſtratum on the ſurface of the liquor. All theſe phenomena gradually ſubſide; the liquor acquires its former limpidity, and, having now obtained an intoxicating quality, is called wine.

§ DCCCXXIX. Although the juice of any vegetable, which contains a certain quantity of ſaccharine matter, be fit for ſpirituous fermentation, and will produce a ſpecies of wine, yet, for economic uſes, we generally employ the following ſubſtances only:

1. The juice of grapes, from which wine, properly ſo termed, is prepared.

2. The juice of apples and pears, which produces cider and perry.

3. Barley, from which ale is made.

4. Honey, whence hydromel.

5. Cherries.

6. Damſons.

7. Rice.

8. Sugar.

The four former kinds are drank entire, but of the latter the ſpirit only.

§ DCCCXXX. The principal conſtituents of all wines are a peculiar volatile fluid called alcohol, a ſalt called tartar, and an extract of gum-reſin, which communicates to the wine its colour, and, in ſome meaſure, its flavour.

§ DCCCXXXI. To ſeparate the alcohol from the other component parts of wine, any quantity of fermented liquor is diſtilled on the water-bath, or by a gentle heat, when the ſpirit will come over into the receiver, in the form of a colourleſs fluid. During this firſt diſtillation, eſpecially if the fire be ſomewhat ſtrong, the alcohol will contain water and ſome etherial oil, from which it may be ſeparated by a ſecond careful diſtillation on the water-bath.

§ DCCCXXXII. The wine which remains after the ſeparation of the alcohol has loſt all odour, and acquired an acid, bitter, and ungrateful flavour. It conſiſts of tartar, gummy, reſinous, and colouring particles, and furniſhes, by proper evaporation, a true extract of wine.

§ DCCCXXXIII. Various methods are employed for aſcertaining the purity of alcohol; among others, it is deflagrated by itſelf, when it ought to leave no water; or it is ſet on fire over gunpowder, which ought to be inflamed by it: But all theſe methods are in a great meaſure fallacious, as they partly depend upon the proportionate quantity of alcohol employed. A better way of examining alcohol is by means of dry pot-aſh, which, at the ſame time that it attracts the water from the alcohol, does not enter into combination, but remains as a peculiar ſtratum at the bottom. But its examination by an aerometer is the moſt preferable method of all.

§ DCCCXXXIV. Pure alcohol is a tranſparent colourleſs liquor, of a hot acrid taſte and agreeable ſmell; but which has ſomething peculiar, according to the ſubſtances from which it is prepared. It cannot be congealed at any known temperature. Its ſpecific gravity is 0.8293. It evaporates in cloſe veſſels without decompoſition, and inflames in contact with the atmoſphere, when it burns with a blue flame, and produces neither ſmoke nor carbon. Water and a little carbonic acid are the only products of its combuſtion.

§ DCCCXXXV. Alcohol combines with water in any proportion; nay, ſuch is its affinity for it, that many neutral ſalts, which alcohol cannot diſſolve, are precipitated by it from their ſolution in water, juſt as other ſubſtances diſſolved in alcohol are precipitated by water. Of this kind is the lac virginis, which conſiſts of the tincture of benzoin and water.

§ DCCCXXXVI. Alcohol is not known to have any action upon metals or earths. It diſſolves ſome neutral ſalts, whilſt others are unaffected by it. The fixed cauſtic alkalis enter into combination with it, and if cauſtic pot-aſh be digeſted for ſome time upon alcohol, we obtain a brown ſolution, which, in pharmacy, is called tincture of pot-aſh. The beſt alcohol diſſolves in this way 0.187 parts of cauſtic pot-aſh.

§ DCCCXXXVII. Cauſtic ammoniac is, in like manner, ſoluble in alcohol. This ſolution is commonly termed vinous ſpirit of ſal ammoniac. It is beſt prepared by the direct mixture of concentrated ſpirit of cauſtic ſal ammoniac (§ CCXXXVI.) with alcohol, or by pouring ſpirit of wine, inſtead of alcohol, into Woulf's apparatus, during the formation of the former.

§ DCCCXXXVIII. Unctuous ſpirit of ſal ammoniac is formed by the ſolution of an etherial oil in the vinous ſpirit of ſal ammoniac; ſuch is the ſpirit of ſal ammoniac prepared with the oil of lavender, commonly termed Aqua anodyna. If ſeveral oils be uſed, it is called Sal volatilis oleoſus.

§ DCCCXXXIX. Mild ammoniac is altogether inſoluble in alcohol, but it is precipitated by alcohol from its ſaturated aqueous ſolution. Hence, if equal parts of concentrated ſpirit of ſal ammoniac be mixed with pure alcohol, a white glacial cryſtalline maſs will be obtained, commonly called Offa Helmontiana, or Sapo chymicus, which gradually deliqueſces on expoſure to the atmoſphere, and is then diſtinguiſhed from diluted vinous ſpirit of ſal ammoniac by the mild ſtate of the ammoniac only.

§ DCCCXL. Almoſt all acids act upon alcohol, and thus produce remarkable phenomena. If an equal portion of concentrated ſulphuric acid be poured upon pure alcohol in a glaſs retort, a conſiderable degree of heat is produced, and vapours, very grateful to the ſmell, are diſſipated. If the mixture be then boiled by the heat of a ſand-bath, connected with Woulf's or any other large receiver, we ſhall obtain the following products:

1. An agreeably-ſcented alcohol, in part united with the following product.

2. A peculiar liquor, known by the name of vitriolic or ſulphuric ether.

3. Volatile ſulphuric acid, with a ſmall quantity of a yellow oil, which is called the ſweet oil of wine.

The fire being now increaſed, the whole mixture paſſes over into the receiver as a ſpongy and dark coloured maſs, but, if the heat be carefully protracted, a dry reſinous ſubſtance will remain in the retort.

§ DCCCXLI. As by frequently opening the joinings much of the ether is loſt, it is cuſtomary to obtain the two former products in the ſame receiver, and then to ſeparate the volatile ether from the alcohol, by repeated diſtillation over the heat of a lamp. In this caſe, a ſmall quantity of pot-aſh is previouſly added to the mixture, to arreſt any ſulphureous acid that may be preſent.

§ DCCCXLII. Ether is a moſt volatile and inflammable fluid, very agreeable to the ſmell, and of an acrid burning taſte. Such is its volatility, that, even under the common temperature of the atmoſphere, it changes into a very inflammable gaz, whoſe ſpecific gravity is greater than that of atmoſpheric air. Its combuſtion is at all times attended by the production of ſoot and of carbonic acid.

§ DCCCXLIII. One part of ether is ſoluble in ten parts of water, which, being thus ſaturated, the remaining ether ſwims upon the ſurface like etherial oil. It does not act upon earths or fixed alkalis, but it unites with ammoniac in any proportion. It combines with gold, diſſolved in the nitro-muriatic acid. It acts upon etherial oils and reſins like alcohol, and is the beſt menſtruum of elaſtic gum.

§ DCCCXLIV. By the union of about an equal portion of alcohol and ether, a liquor is produced called Hoffman's anodyne liquor. To prepare it in a more economical way, one part of ſulphuric acid is poured upon three parts of alcohol, and diſtilled by a gentle heat, as before, till ſulphureous acid vapours begin to come over. If, by the inattention of the operator, any of theſe paſs over into the receiver, the liquor obtained muſt be re-diſtilled with a ſmall portion of pot-aſh. The above-mentioned mixture is alſo prepared without diſtillation, when it is called dulcified elixir of vitriol, or Rabel's water.

§ DCCCXLV. The nitric acid acts even more readily and more powerfully upon alcohol than the ſulphuric acid. If equal parts of fuming ſpirit of nitre and alcohol be mixed, the heat of the mixture ſpontaneouſly increaſes to ebullition, and at firſt a gazeous fluid of a grateful ſmell, termed ether of nitre, is evolved; this is ſucceeded by a conſiderable quantity of nitrous gaz, and a ſmall portion of an acid liquor remains, which, when evaporated, produces a ſalt, formerly termed Hierne's cryſtals, and is a true acid of ſugar.

§ DCCCXLVI. Hence ether of nitre is but with great difficulty obtained in a liquid ſtate. The following method, however, is moſt to be recommended: a tubulated retort, placed on a ſand-bath, is connected with ſome of Woulf's receivers; two parts of nitre, previouſly dried, are then put into the retort and gradually affuſed with two parts of a mixture of equal parts of ſulphuric acid and alcohol. Thus the nitre is decompounded, and the fuming and gazeous nitrous acid, combined with alcohol in the form of ether of nitre, paſſes over into the receivers, where it is obſerved to float upon the ſurface of an acidulous liquid.

§ DCCCXLVII. Nitrous ether is always of a yellow hue, and poſſeſſes all the properties of ſulphuric ether, except that its taſte is more acrid. Combined with alcohol, it forms the ſweet ſpirit of nitre, which is generally prepared in the following manner: either one part of aqua fortis and four parts of alcohol, or one part of fuming ſpirit of nitre and twelve parts of alcohol, are diſtilled from a glaſs retort into a common receiver, until the liquor which paſſes over becomes ſomewhat acid. In the retort there remains a little acid of ſugar. When the ſweet ſpirit of nitre is properly prepared, it ought not to effervefce with mild alkalis, which would be a ſign of its containing free nitrous acid, either from age, or from its being prepared in an improper manner.

§ DCCCXLVIII. The action of common muriatic acid upon alcohol is not conſiderable, and if even 10 parts of alcohol, mixed with one part of concentrated muriatic acid, be diſtilled by a moderate heat, ſtill the product is merely a kind of ſweet ſpirit of ſalt, which always poſſeſſes an acidulous and acrid taſte. In order, therefore, to prepare it of a better kind, or, indeed, to obtain muriatic ether, we have adopted various methods, but all of which require that the muriatic acid ſhould be previouſly changed into the oxygenated ſtate. The following method ſeems to be the beſt: let five parts of concentrated muriatic acid and three parts of alcohol be affuſed upon 1½ parts of common oxide of manganeſe in a retort, which is to be placed on a ſand-bath and connected with Woulf's receivers, the laſt jar of which ought to contain a ſmall portion of alcohol. After the diſtillation is concluded by a gentle heat, you obtain the real ſweet ſpirit of ſalt, which, mixed with an acidulous liquor, collects in the empty receiver, while the alcohol, contained in the laſt receiver, on account of the attraction of etherial gaz, is, in like manner, changed into a weak ſweet ſpirit of ſalt. By diſtillation with a ſmall quantity of pot-aſh, not only ſweet ſpirit of ſalt but even true muriatic ether may be obtained from the firſt liquor, on which occaſion a ſmall portion of heavy etherial oil is ſeparated in the ſame manner as in the preparation of ſulphuric ether.

§ DCCCXLIX. Almoſt all the other known acids act upon alcohol in nearly the ſame manner as the three mineral acids above-mentioned, whence ariſes acetic ether, oxalic ether, formic ether, &c. which, in a great meaſure, agree in their chief properties with thoſe already mentioned.

§ DCCCL. The theory of the formation of ether, and its chemical compoſition, is as yet obſcure, although from the phenomena with which we are acquainted, it is very probable that the oxygen of the acids, united, either entirely or in part, with the alcohol, tends chiefly to the formation of theſe liquids.

§ DCCCLI. Alcohol combines very readily with the aroma of plants, with which it ſeems to have a greater affinity even than water and etherial oils. Hence, if vinous ſpirit be diſtilled upon aromatic parts of vegetables, it becomes impregnated with their aroma, and is then called aromatic ſpirit. But if a mixture of water and ſpirit of wine, or wine only, be employed in this operation, the fluid obtained, in which the aroma is diſſolved, both in the water and ſpirit of wine, is called vinous diſtilled water. Both may be either ſimple or compound, according as one or more ſpecies of plants are employed.

§ DCCCLII. Aromatic ſpirits are beſt prepared on the water-bath; but even in this caſe the diſtillation ſhould not be extended to dryneſs, becauſe the laſt products are frequently leſs agreeable to the ſmell than the firſt. Beſides, the quality of this ſpirit depends, in a great meaſure, upon the purity of the alcohol; nor do ſuch as are newly prepared poſſeſs that agreeable flavour which the older and better preſerved ſpirits are remarkable for.

CXII. OF TARTAR.

§ DCCCLIII. Tartar, as it is obtained from the ſpontaneous depoſit of wine, is alloyed with much extractive and colouring matter, from which it is purified by decoction with fat argillaceous earths, and by ſubſequent cryſtallization. When thus treated, it becomes perfectly white, and ſhoots into cryſtals of a tetraëdral pyramidal form, called cryſtals or cream of tartar.

§ DCCCLIV. Theſe cryſtals of tartar are a neutral acidulous ſalt, conſiſting of a peculiar acid, the acid of tartar, and pot-aſh. It is ſoluble in 28 or 30 parts of boiling water, and cryſtallizes again during refrigeration. If this ſalt be completely ſaturated with pot-aſh, a neutral ſalt is formed, the cryſtals of which are tetraëdral columns, deliqueſcent in the atmoſphere, called tartrite of pot-aſh.

§ DCCCLV. But if the acid of tartar be ſaturated with ſoda, we ſhall obtain a compound neutral ſalt, which ſhoots into large cryſtals, and effloreſces in the atmoſphere, viz. the tartrite of ſoda.

§ DCCCLVI. When completely ſaturated with ammoniac, it forms a neutral ſalt, which ſhoots into rhomboidal cryſtals, unchangeable in atmoſpheric air, termed tartrite of ammoniac.

§ DCCCLVII. To obtain the pure tartareous acid from tartar, we proceed in the following manner. The ſuperabundant acid of a boiling ſolution of tartar is ſaturated with pure chalk, by which means we obtain an earthy ſalt, inſoluble in water, which is ſeparated by filtration from the remaining liquid, now conſiſting of mere tartrite of pot-aſh. This calcareous tartrite is afterwards digeſted with diluted ſulphuric acid, and the acid of tartar is ſeparated by filtration from the ſulphate of lime. This ſtrained lixivium affords, by refrigeration and evaporation, regular tetraëdral columnar cryſtals of a pleaſant acid taſte.

§ DCCCLVIII. If the cryſtals of tartar be diſtilled by a ſtronger heat, without any additional body, they furniſh an empyreumatic acid, called the pyro-tartareous acid, or ſpirit of tartar, and a very fetid empyreumatic oil. In the retort their remains a coal which already contains a great deal of pot-aſh; but the aſhes of this coal contain a ſtill greater quantity of pot-aſh, ſcarcely any earth, and no neutral ſalts. This mild pot-aſh, when freed from its earthy particles, is generally called ſalt of tartar, and, when liquefied in the atmoſphere, oil of tartar.

CXIII. OF THE ACID FERMENTATION.

§ DCCCLIX. All bodies which have undergone the firſt or ſpirituous fermentation are capable of paſſing on to the ſecond, or acid fermentation; but, although it be probable that the acid fermentation never takes place before the body has gone through the ſpirituous fermentation, yet the duration of the firſt is frequently ſo ſhort and imperceptible, that it cannot be aſcertained. Beſides the bodies which are proper for ſpirituous fermentation, this claſs includes all ſorts of feculæ boiled in water.

§ DCCCLX. The conditions required for the acid fermentation are:

1. A heat from 20 to 25 degrees of Reamur.
2. A certain degree of liquidity.
3. The preſence of atmoſpheric air.
4. A moderate quantity of fermentable matter.

The phenomena which accompany this fermentation are an inteſtine motion and a conſiderable abſorption of air. The tranſparent liquor becomes turbid, but regains its limpidity when fermentation is over.

§ DCCCLXI. The fermented liquor conſiſts now, in a great meaſure, of a peculiar acid, called the acetous acid or vinegar. Not a veſtige of alcohol remains, it being entirely decompounded; but the greater the quantity of alcohol in the liquor, previous to the fermentation, the greater will be the quantity of true vinegar obtained. The vinegar is always of a deeper colour than the wine, and corrupts when kept for a long time in a warm place.

§ DCCCLXII. Vinegar is concentrated by freezing. The acid of vinegar itſelf does not freeze, but the water only. If, therefore, the ice be ſeparated from the remaining liquid, a much ſtronger vinegar will be obtained. According to this method, however, the acetous acid is not purified, that is, ſeparated from its colouring and extractive matter.

§ DCCCLXIII. If vinegar be diſtilled from a retort, by a fire gradually increaſed, at firſt an acidulous phlegm comes over, which is ſucceeded by a ſtronger acid of an agreeable odour, called diſtilled vinegar. This continually increaſes in ſtrength, but becomes ſoon tainted with an empyreumatic ſmell. Towards the concluſion of the operation, we obtain a very ſtrong acetous acid, an empyreumatic oil, and a little mild ammoniac.

§ DCCCLXIV. This acetous acid is colourleſs, and has, for the moſt part, a ſlight empyreumatic ſmell. When completely ſaturated with pot-aſh, it forms a neutral ſalt, the terra foliata tartari, properly termed acetite of pot-aſh. For this purpoſe, we boil an aqueous ſolution of pure pot-aſh in a glaſs or tin veſſel, and add diſtilled vinegar till effervefcence ceaſes, and even ſomewhat longer. This lixivium being then carefully, and by degrees, evaporated to dryneſs, a white and foliated ſalt is obtained, viz. the acetite of pot aſh, which deliqueſces in the atmoſphere, when it forms what is called, in pharmacy, liquor of the foliated earth of tartar.

§ DCCCLXV. As even a moderate heat is apt to burn the diſtilled vinegar, and to cauſe the acetite of pot-aſh to aſſume a yellow or brown colour, and as, for medicinal purpoſes, this ſalt is generally prepared from common vinegar, when it retains all the colouring and extractive matter, various methods have been propoſed to deprive it of its brown colour. The principal of theſe are, 1, the ſalt, previouſly dried, is fuſed, and continually agitated in an earthen, or, which is preferable, a ſilver veſſel, till the vapours emitted from it inflame, when the ſalt is again diſſolved, filtrated, and, after adding a ſmall portion of diſtilled vinegar, carefully evaporated: 2, the lixivium to be evaporated is mixed with powdered charcoal, and not filtrated till it becomes almoſt dry, when it is evaporated to dryneſs on the water-bath.

§ DCCCLXVI. The foliated earth of tartar is of a taſte ſomewhat acrid, and eagerly attracts humidity from the atmoſphere. It is readily diſſolved in an equal portion of cold and hot water, and if the ſolution be evaporated to the conſiſtence of ſyrup, and then cooled, cryſtals in the form of ſmall needles will be obtained. It is alſo perfectly ſoluble in ſpirit of wine, and requires two parts of alcohol for entire ſolution.

§ DCCCLXVII. From the combination of diſtilled vinegar and ſoda, a neutral ſalt is formed, which ſhoots into columnar cryſtals, not deliqueſcent, but effloreſcent in the atmoſphere, called acetite of ſoda, or dry foliated earth of tartar. It is prepared in the ſame manner as the former. This ſalt is alſo very ſoluble in ſpirit of wine, and, like acetite of pot-aſh, is decompounded by the mineral acids and by fire. The acids ſeparate the acetous acid in a very concentrated ſtate, or as radical vinegar, (§ DCCCLXXIII.) But fire decompoſes the acid itſelf, which paſſes off in the form of hydrogen and carbonic acid gaz and ammoniac.

§ DCCCLXVIII. Diſtilled vinegar, when ſaturated with ammoniac, forms a neutral ſaline liquid, which is named acetite of ammoniac, or Spirit of Mindererus. To obtain it in the moſt concentrated ſtate, it is beſt to ſaturate very ſtrong diſtilled vinegar with dry mild ammoniac. The cryſtallization of this acetite of ammoniac is extremely difficult. If it be diſtilled by itſelf from a retort, it ſublimes at laſt in the form of a white ſaline cruſt, which is acetite of ammoniac in a dry ſtate.

§ DCCCLXIX. The acid of vinegar combines with all the alkaline earths, and thus generates peculiar earthy ſalts, all of which are very ſoluble in water, ſcarcely cryſtallizable, deliqueſcent in the atmoſphere, and decompoundable by fire. In like manner the acid of vinegar acts upon moſt metals, either in a metallic or oxided ſtate, and forms with them peculiar metallic ſalts, of which the following are the principal.

§ DCCCLXX. Copper, in its metallic ſtate, but much more readily in the ſtate of oxide, is diſſolved in vinegar. The metallic copper is at firſt only corroded or oxided by the vinegar, which operation is performed, in the ſouth of France, by ſtratifying the huſks of grapes, in a ſtate of fermentation, with plates of copper. The green oxide of copper, ſcraped from the plates, is known, in commerce, by the name of verdegris, and contains but little acetite of copper.

§ DCCCLXXI. This oxide is very readily and perfectly diſſolved in diſtilled vinegar, and forms a blue ſolution, which, by evaporation and cooling, depoſits beautiful green cryſtals of a tetraëdral, pyramidal, and truncated form, termed diſtilled verdigris, or acetite of copper.

§ DCCCLXXII. The acetite of copper has a very ſtiptic taſte; it is perfectly ſoluble in ſpirit of wine; alſo in five parts of boiling water. On expoſure to the atmoſphere it becomes a pale green powder.—It is decompounded by alkaline ſalts and earths, which precipitate the copper in the ſtate of a green oxide, except ammoniac, which immediately diſſolves the precipitate.

§ DCCCLXXIII. If the acetite of copper, reduced to powder, be diſtilled from a retort, we obtain, in the firſt place, the water of cryſtallization, which is ſucceeded by a colourleſs, limpid, highly concentrated acid, of a ſtrong, acrid, acetous ſmell, called radical vinegar. If the fire be not too ſtrong towards the end of the operation, there remains in the retort a brown powder, which is copper in a metallic ſtate, and of the nature of pyrophori.—As the radical vinegar contains frequently a little copper, we commonly rectify it by re-diſtillation over a gentle fire, but not extended to dryneſs.

§ DCCCLXXIV. Radical vinegar differs eſſentially in many of its properties from common diſtilled vinegar, and is conſidered by modern Chemiſts as perfect acid of vinegar, or the acetic acid, whilſt common diſtilled vinegar is conſidered as imperfect acid of vinegar, or acetous acid. This opinion is confirmed by the phenomena attending its preparation.

§ DCCCLXXV. Radical vinegar is very acrid, cauſtic, and ſo volatile, that it evaporates at the common temperature of the atmoſphere. The vapours which it emits, when heated, are inflammable, and on this occaſion the vinegar itſelf ſeems to burn. It forms with alkalis and alkaline earths peculiar neutral ſalts, which are different from thoſe generated by common vinegar. When properly diſtilled with alcohol, it produces acetic ether.

§ DCCCLXXVI. Lead, in its metallic ſtate, but more readily in its ſtate of oxide, is ſoluble in diſtilled vinegar, which ſolution is termed acetite of lead. For medical purpoſes, this ſubſtance is prepared by diſſolving litharge to the point of ſaturation, in good common vinegar, which ſolution, evaporated to the conſiſtence of ſyrup, is called extract of lead.

§ DCCCLXXVII. If thin plates of lead be expoſed to the vapours of vinegar, they are covered with a white powder, which being ſcraped off is called ceruſe or white lead; this ceruſe is not acetite of lead, but carbonate of lead only. When diſſolved to the point of ſaturation in diſtilled vinegar, it becomes acetite of lead, which, by evaporation and cooling, depoſits ſmall, white, acicular, or tetraëdral priſmatic cryſtals, viz. acetite of lead, or ſugar of lead.

§ DCCCLXXVIII. Acetite of lead is of a ſweet ſtyptic taste, and falls to powder on expoſure to the atmoſphere. It is perfectly ſoluble in water and ſpirit of wine, requiring about equal parts of each, under the common temperature of the atmoſphere. It is decompoundable by fire, and by alkaline earths and ſalts. Fire expels the acid partly undecompounded, but the latter precipitate the lead in the form of a white oxide. It is alſo decompounded by the nitric and ſulphuric acids, and by the alkaline and earthy ſulphates. The ſulphuric acid diſengages the acid in the ſtate of radical vinegar.

§ DCCCLXXIX. Sulphurets, and water containing ſulphurated hydrogen gaz, decompound acetite of lead, when the ſulphur, together with the lead, is precipitated in the form of a dark brown powder. Sulphurets, or rather ſulphurated hydrogen gaz, is, therefore, very uſeful in detecting the adulteration of wines with ſugar of lead. For this purpoſe it is beſt to uſe water impregnated with ſulphurated hydrogen gaz, according to the following method of Hahnemann. Equal parts of powdered oiſter-ſhells and ſulphur are mixed and heated to candeſcence, for the ſpace of 12 minutes, in a covered crucible. The whitiſh grey powder, or ſulphuret of lime, thus obtained, is then kept for uſe in a bottle well corked. Now, if we wiſh to prove the quality of wine, we put two drams of this powder into a bottle with ſeven drams of cryſtals of tartar, finely powdered, and affuſe 16 ounces of pure cold water; the bottle is then agitated for about 10 minutes, and the liquor ſuffered to depoſit its ſediment. If a table ſpoonfull of the clear liquor be now poured upon four or ſix ounces of the wine to be examined, a precipitate more or leſs black will follow, if the wine be adulterated with lead.

§ DCCCLXXX. The acetous acid has but a weak action upon mercury when in the ſtate of metal, but if oxide of mercury, (§ DXXXV.) or the yellow precipitate of this metal (§ DXXXIX.) be boiled with vinegar, a ſolution is formed, which, on cooling, affords ſmall ſcaly cryſtals of a ſilver ſplendour, termed acetite of mercury, or terra foliata mercurialis. This ſalt is more readily prepared, by adding a ſolution of the foliated earth of tartar to a nitric acid ſolution of mercury; for the nitric acid combines with the pot-aſh, and forms nitre, whilſt the acetous acid unites with the mercury, and is precipitated in the form above mentioned. This neutral ſalt is difficultly ſoluble in cold water, but more eaſily in boiling water. Too great a portion of water, however, decompoſes it, and precipitates a yellow calx. It is likewiſe decompounded by fire and alkalis.

§ DCCCLXXXI. Regulus of antimony, in like manner, is only acted upon by vinegar when in an oxided ſtate, and by the aid of digeſtion. But the ſolution, thus obtained, affords no cryſtals. Vinegar has ſcarcely any effect upon tin, even when reduced to the ſtate of calx.

§ DCCCLXXXII. Vinegar, aided by the water which it contains, diſſolves the gum and vegetable mucilage, as well as the etherial oil, the aſtringent and extractive particles of plants; therefore, by the maceration of different plants, or of ſome of their parts, in common diſtilled vinegar, we form thoſe medicaments which are called, in pharmacy, medicated vinegars. But, if common vinegar be diſtilled upon aromatic vegetables, we obtain a diſtilled vinegar, impregnated with the aroma of the plants. Of this kind is the aqua vulneraria cum aceto. The acetous acid does not diſſolve pure reſins, and only diſſolves camphor when highly concentrated. It ſoftens gum-reſins.

§ DCCCLXXXIII. The compoſition of the acetous acid is probably the ſame as that of all other vegetable acids, (§ DCCCXXV.) differing only in the proportion of its conſtituent parts. This is obvious from the circumſtance that the acid of tartar and of ſugar, when oxided to a higher degree, are changed into acetic acid; for if theſe two acids be treated in the dry way with the oxide of manganeſe, or with nitric acid, a liquor is obtained which poſſeſes the ſame flavour and properties as acetous acid.

CXIV. OF THE PUTREFACTION OF VEGETABLES.

§ DCCCLXXXIV. Vegetables are liable to putrefy, if the neceſſary conditions be preſent. Some undergo this change immediately, without any previous fermentation; ſuch are plants of the ſecond claſs: many plants, on the contrary, do not become putrid till they have gone through the acid fermentation; to this claſs belong alſo ſuch vegetable juices as have paſſed through the ſpirituous fermentation.

§ DCCCLXXXV. The conditions neceſſary for putrefaction are not ſo limited as thoſe for ſpirituous and acid fermentation; the following are, however, indiſpenſably requiſite:

1. A certain degree of moiſture, for vegetables which are perfectly dry do not putrefy.

2. A temperature of five degrees, at leaſt, above the freezing point.

3. The preſence of atmoſpheric air. But this circumſtance is here leſs neceſſary than in the two preceding fermentations.

4. A certain degree of mixture, for alcohol, acetous acid, reſins, etherial and fat oils, do not putrefy when pure.

§ DCCCLXXXVI. The phenomena which accompany putrefaction are an inteſtine motion, but which is not ſo evident as in the ſpirituous and acid fermentation. Liquid putrefiable matters alſo become turbid; but the degree of heat excited is not very diſcernable; in drier putreſcent maſſes, on the contrary, it is frequently ſo great as to produce ſpontaneous inflammation. But the moſt remarkable phenomena, in putrid fermentation, are a change of ſmell, which, even in aromatic plants, becomes ungrateful and nauſeous; alſo the production of hydrogen, nitrogen, and carbonic acid gaz; and finally the formation of ammoniac, which gradually eſcapes from the maſs. After the putrefaction is completed there remains a ſoft maſs, in which ſcarcely any one of the conſtituents of the vegetables can be diſcovered, except ſome colouring matter. This putrefied maſs gradually dries into a black powder, which conſiſts of earth and a little ſaline matter, known by the name of vegetable mould.

§ DCCCLXXXVII. The putrefied vegetable maſs, as well as the mould, affords, by diſtillation, a fetid water, ammoniac, a fetid empyreumatic oil and charcoal, the aſhes of which, when burnt, contain a little pot-aſh.

XXV. THEORY OF FERMENTATION.

§ DCCCLXXXVIII. Although there can be no doubt that all vegetable ſubſtances are reſolved into their remote principles during the three fermentations, and that theſe parts, thus ſet at liberty, recombine in different proportions and under different circumſtances, to form thoſe new bodies which are the products of all fermentation, yet neither thoſe proportions nor circumſtances are accurately known to us, and, in this reſpect, the theory of fermentation is ſtill very obſcure and doubtful.

§ DCCCLXXXIX. Since ſugar, or bodies containing a great quantity of ſaccharine matter, are fit for ſpirituous fermentation, and as ſuch bodies are compoſed of carbon, hydrogen, and oxygen (§ DCCCXXV.) Mr. Lavoiſier was of opinion that the hydrogen unites with a portion of carbon, and forms alcohol, while another portion of carbon combines with oxygen, and produces carbonic acid; for both alcohol and carbonic acid are the products of ſpirituous fermentation

§ DCCCXC. Vinegar is an imperfect acid, and has a compound baſis, which, probably, conſiſts of hydrogen and carbon. Hence it is obvious why alcohol, when oxygenated, becomes vinegar, and why the preſence of atmoſpheric air is indiſpenſably requiſite during this change. But why pure alcohol cannot undergo the acid fermentation, unleſs mucilage be preſent, is a fact which remains to be explained.

§ DCCCXCI. In putrefaction, the remote principles of plants are almoſt entirely converted into gazeous bodies. In plants of the firſt claſs, the hydrogen eſcapes by itſelf, in the ſtate of inflammable air; but the carbon, combined with oxygen, paſſes off in the form of carbonic acid gaz; nor is the reſidue compoſed of any thing elſe but earth and metallic particles, perhaps united to a ſmall portion of carbon. But if plants, like thoſe of the ſecond claſs, contain more nitrogen, this body, during putrefaction, combines with hydrogen, and forms ammoniac. The phoſphorus, of which theſe plants contain a ſmall portion, is diſſolved by the inflammable gaz, and paſſes off with it in the ſtate of phoſphorized hydrogen gaz. On account of this gaz, and the greater proportion of ammoniac, vegetables of the ſecond claſs produce always a more diſagreeable ſmell, during putrefaction, than thoſe of the firſt claſs.

CXVI. OF SOME PARTICULAR PHARMACEUTICAL PREPARATIONS.

§ DCCCXCII. *Elæoſaccharum* is the combination of a volatile oil and ſugar, without heat. It is prepared in three ways:

1. By cauſing a drop of the oil to be imbibed by a piece of ſugar.

2. By pounding one dram of ſugar with one, two, or three drops of the etherial oil, according as the oil is more or leſs acrid.

3. By rubbing the peel of an orange or lemon upon a lump of ſugar, and afterwards ſeparating the impregnated part.

§ DCCCXCIII. Tabulæ and paſtæ are compoſed of ſugar and vegetable mucilage. The former are prepared in the cold; but the latter by the aid of heat. The ſolid parts of vegetables, reduced to a fine powder, are frequently made uſe of for tabulæ. *Trochiſks* differ from tabulæ chiefly in their more extenſive compoſition and external form.

§ DCCCXCIV. *Rotulæ* are formed when ſugar is melted upon the fire with the recent juices of vegetables, diſtilled waters, etherial oils, &c. and poured, by drops, upon a marble-table. *Morſuli* differ from the former, becauſe ſolid parts of plants, merely bruiſed or chipped, are mechanically mixed with them.

§ DCCCXCV. We obtain a *conſerve*, if the recent and tender parts of vegetables, ſuch as leaves and flowers, be pounded in a mortar, of marble or wood, to a pultaceous conſiſtence, and mixed, according to the ſucculency of the plants, with two or three times the quantity of ſugar. A little water is added to the drier plants, when bruiſed, as for example to roſes.

§ DCCCXCVI. Conſerves ought to be of the conſiſtence of an inſpiſſated pap, and ſhould ſcarcely adhere to the fingers; for they are apt to ferment, if too liquid. Even in the beſt-made conſerves we may notice during the firſt days a ſlight inteſtine motion; they ſwell, and the ſolid parts are ſeparated from the more liquid. Unleſs this ſeparation be prevented by repeated ſtirring, the more liquid part ferments, and thus the conſerve becomes unfit for uſe.

§ DCCCXCVII. Conſerves are leſs liable alſo to ferment, if kept in a cool place. But with all our care we can ſcarcely preſerve them longer than a year; for, as their virtue depends, in a great meaſure, upon the volatile parts, they, in general, loſe their efficacy by age. Hence they ought only to be prepared for a ſingle year's conſumption, nor even for ſo long, if the plants can be had freſh during the whole year.

§ DCCCXCVIII. Conſerves are alſo made, in caſes of neceſſity, from dry plants reduced to powder, with the addition of ſome water: but conſerves, formed in this manner, have an earthy taſte, and are not ſo ſoluble in the mouth as thoſe prepared from the freſh plants; nor can they be ſo powerful.

§ DCCCXCIX. When ſugar is diſſolved in any vegetable liquor, as an infuſion, decoction, emulſion, expreſſed juice, &c. to the conſiſtence of honey, a medicinal preparation is formed, called ſyrup, which, if obtained from a ſingle plant, is termed ſimple; but, if more than one be employed, compound. The manner of preparing the ſyrup differs, according to the difference of the liquor uſed; hence there are general rules which apply to all ſyrups, and particular rules, which are applicable to a few ſyrups only.

§ DCCCC. Sugar is added to the above-mentioned liquors, that they may be preſerved from corruption, and principally to prevent them from being fermented; but to this end it is neceſſary that it ſhould be employed in a certain proportion. If a ſyrup contain too ſmall a proportion of ſugar, it becomes too liquid, and is then even more liable to ferment than if it contained none at all. On the contrary, if a ſyrup has too much ſugar, that is, more than the liquor can hold in ſolution, when cooled, the ſuperfluous quantity cryſtallizes, and takes away a conſiderable portion of that ſugar alſo which is neceſſary to the preparation, by which means the ſyrup is again rendered too thin, and ferments. The quantity of ſugar depends, therefore, alſo upon the conſiſtence of the liquid. For the juices of fruits, infuſions, and decoctions, we generally take a double quantity of ſugar; but for inſpiſſated liquids, emulſions for example, an equal quantity is ſufficient.

§ DCCCCI. It is the mucilaginous part of plants principally which excites the acid fermentation; therefore, the more mucilage a ſyrup contains, the ſooner and more eaſily is fermentation produced; and the better the liquor is clarified with white of egg, either before or after the ſugar is added, the longer will it remain perfect. By this means ſyrups alſo become more agreeable to the eye, but at the ſame time they generally loſe ſomething of their medicinal virtue. It is beſt, therefore, to purify a ſyrup by deſpumation, when boiling, and ſubſequent filtration through flannel.

§ DCCCCII. As the acid fermentation requires a temperature ſomewhat higher, the fermentation of ſyrup is alſo prevented by keeping it in a cool place. Syrup, which has juſt begun to ferment, may be corrected by boiling it a ſecond time with the addition of a ſmall portion of ſugar; but the fermentation is not ſuppoſed to have extended ſo far that the properties of the ſyrup are changed.

§ DCCCCIII. Syrups ſhould be always preſerved in glaſs or earthen veſſels, or ſuch as are made of pure tin, for moſt ſyrups contain acid particles, and even ſugar has ſome action upon copper or iron veſſels. It is likewiſe requiſite that ſyrups be well cooled before they are poured into the veſſels, for otherwiſe the ſteam which condenſes on the upper part of the veſſel falls upon the ſurface of the ſyrup, and produces mouldineſs. With regard to the veſſels in which the ſyrup is prepared, the ſame obſervations are applicable which we made (§ DCCII. DCCIII.) when treating of extracts.

§ DCCCCIV. Sugar is frequently added to decoctions in the firſt inſtance, which are then evaporated to the proper conſiſtence. All unneceſſary ebullition ought, nevertheleſs, to be prevented as much as poſſible. Emulſions, infuſions, and the expreſſed juices of fruits, ſhould never be boiled with ſugar, but ſhould be ſimply diſſolved in them, and at moſt heated to one ebullition. Sometimes the ſolution ought to be made on the water-bath, as in the preparation of ſyrup of violets, to preſerve the beauty of the colour.

§ DCCCCV. Syrups prepared with honey, inſtead of ſugar, are named *Mella.* For this purpoſe honey is added to the liquid, and afterwards evaporated again to the conſiſtence of honey. What is thus prepared with vinegar is called ſimple *Oxymel;* but if a third liquor be added, as for example the juice of ſquills, it is then termed *Oxymel* of *ſquills.*

§ DCCCCVI. If the juice or pulp of fruit be boiled with one fourth part of ſugar to the conſiſtence of an extract, the former is called *Roob*, and the latter *Pulp;* but, if an equal portion of ſugar be added to theſe juices, and then evaporated to a certain degree, *Jellies* will be obtained. Thoſe prepared with vegetable mucilage are termed *Paſtæ.*

§ DCCCCVII. The dry parts of plants reduced to powder, extracts, conſerves, balſams, oils, gums, or reſins, when mixed with ſyrup or honey, to the conſiſtence of a liquid extract, form *Electuaries.*— Theſe are for the moſt part very compound, and commonly undergo, from the firſt, a kind of fermentation, which ſometimes continues for years. But the medicinal virtue of moſt of them is not in conſeqeunce materially affected. The virtue of others, however, is actually changed, for which reaſon they ſhould not be prepared in great quantity.

§ DCCCCVIII. *Artificial balſams* are generally compoſed of expreſſed or etherial oils, reſins, and other ſolid bodies, which give them the conſiſtence of butter. The baſis, or body, of moſt of them is the expreſſed oil of nutmeg, and frequently wax, butter, &c. They are uſually tinged with ſoot, ſaffron, cinnabar, &c.

§ DCCCCIX. *Ointments* conſiſt chiefly of wax, honey, expreſſed oils, animal fat, butter, reſins, and the like, which are liquefied or boiled with the recent or dried parts of plants, metallic calces, ſulphur, acetite of lead, and other ſubſtances, to the conſiſtence of butter. Mercurial ointment differs from theſe as it is merely an oxidation and ſolution of mercury in hog's lard by continued trituration. Ointments which are leſs ſolid than butter are called *Liniments*; and ſuch as are more ſolid, *Cerates*.

§ DCCCCX. *Plaſters* are diſtinguiſhed from ointments principally by their ſolidity, for they may be handled without adhering to the fingers, and be thus formed into rolls. Wax, reſins, or the oil of olives, boiled with oxide of lead, conſtitute their baſes. Whence they are divided into two ſpecies, viz. into cerated and ſaturnine plaſters.

THE ANIMAL KINGDOM.

§ DCCCCXI. A living animal body conſiſts of liquid and ſolid parts, which are gradually formed from the nutriment by means of the organic ſtructure of the veſſels, and conſtantly renovated and ſeparated from the body as excrements of various kinds. Theſe ſubſtances may be properly divided into three claſſes: firſt, into ſuch as form a neceſſary conſtituent of the living body; ſecondly, into excrements; and thirdly, into parts ſecreted for particular purpoſes. But it is to be regretted that our knowledge of the chemical properties of thoſe ſubſtances is as yet too limited and unconnected to treat ſatisfactorily on the nature of animal bodies in the order juſt mentioned. We muſt therefore be contented to examine the liquid and ſolid parts of animals in that ſeries, in which their chemical properties are more or leſs known.

CXVII. OF MILK.

§ DCCCCXII. Milk is a white liquid, ſomewhat ſweet, of a faint ſmell, ſecreted in the breaſts of the female of lactiferous animals, for the ſupport of the young in the firſt ſtage of life. This liquid varies not only in different ſpecies of animals, but even in the ſame animal, according to circumſtances, but chiefly from the nature of the food. We will examine the milk of cows.

§ DCCCCXIII. The new milk of cows, when diſtilled on a water-bath, affords an inſipid phlegm, which is impregnated with the aroma of milk, and putrefies in a ſhort ſpace of time. All the remaining milk is changed into a dry powder, a true extract of milk, which, when diſſolved in hot water, affords the original milk, but altogether void of ſmell.

§ DCCCCXIV. By diſtilling this extract on a ſand-bath, we obtain hydrogen gaz, carbonic acid gaz, ſome empyreumatic acid, an empyreumatic oil, and ammoniac. The reſidue, in the retort, is a coal, the aſhes of which contain ſome pot-aſh, muriate of pot-aſh, and phoſphate of lime.

§ DCCCCXV. New milk does not appear to contain the leaſt acid or alkali. When at reſt, an inſpiſſated ſubſtance is collected on its ſurface, termed cream, which being removed, the remainder is called ſkimmed milk. If cream, by continued agitation, be freed from the adhering milk, we obtain an oily ſubſtance, viz. butter; and the milk thus ſeparated, which is now ſomewhat acid, is called butter-milk. All bodies which render fat oils ſoluble in water retard or impede the ſeparation of butter. Too great a degree of either heat or cold does the ſame.

§ DCCCCXVI. By a ſlight digeſtion of ſome hours, the ſkimmed milk ſeparates again into a ſolid coagulum, or curd, and into a tranſparent liquid, the ſerum or whey of milk. Although this ſeparation takes place ſpontaneouſly, yet it is more ſpeedily effected by the addition of various bodies, as all acids, neutral ſalts, rennet, the internal membrane of the ſtomach of hens, the human ſtomach, the yolk of egg, gum, ſugar, ſpirit of wine, &c. It is alſo promoted by a temperature increaſed to ebullition.

§ DCCCCXVII. Some vegetables alſo, as Galium, Vaillantia cruciata, madder, thiſtle, &c. accelerate the ſeparation of the cheeſy part of milk; but, according to my obſervations, then only when they are added to the milk in the cold, or when a cold aqueous infuſion of them is mixed with milk. If thoſe vegetables be boiled in milk, or thrown into hot milk, the coagulation, inſtead of being promoted, is rather retarded. Nor has the infuſion of theſe plants prepared by heat, their decoction, or even diſtilled water, any effect upon milk.

§ DCCCCXVIII. The cauſtic alkalis, which diſſolve the caſeous part of milk, do not coagulate it. The mild alkalis do coagulate milk, but in a different manner from the bodies before mentioned, for they unite with the butter and cheeſe, and form a ſaponaceous maſs, which ſeparates from the milk in the form of denſe white flocculi, which become yellow by continued ebullition, and at length brown. Lime-water alſo does but produce an imperfect coagulation in milk.

§ DCCCCXIX. The firſt conſtituent parts of milk are, therefore, ſerum, butter, and cheeſe, which, on account of the incipient acid fermentation of the ſerum, or by means of other bodies which coagulate the cheeſy part, ſeparate from each other. If new milk be treated as mentioned (§ DCCCCXVI.), then the cheeſy part, mixed with butter, is ſeparated from the ſerum.

§ DCCCCXX. The ſerum of milk has a ſweet agreeable taſte, and poſſeſſes the odour of milk, when prepared without boiling. It is always turbid, and can only be clarified by the white of egg. By diſtillation on the water-bath, we obtain from it the ſame water which is afforded by new milk; and there remains a maſs, which, when freed from the cheeſy and other adhering parts, ſhoots into white rhomboidal cryſtals, termed ſugar of milk.

§ DCCCCXXI. This ſugar of milk has an inſipid ſweetiſh taſte, and is perfectly ſoluble in four parts of boiling water; it exhibits the ſame appearances as common ſugar, when diſtilled by a ſtronger heat. If one part of ſugar of milk be treated with nine parts of nitric acid, as in the preparation of the ſaccharine acid, (§ DCCLXXII.) a white powder is ſeparated during the operation, and the remaining liquor ſhoots into long cryſtals, which are a true acid of ſugar.

§ DCCCCXXII. The powder above mentioned has an earthy taſte, and is difficultly ſoluble in water*.

---

* According to Scheele, it requires 60 parts of boiling water, or 80 of cold water, to be diſſolved. T.

When diſtilled it becomes black, and is partly ſublimed as an acid ſalt, ſimilar to the ſuccinic acid, with a reſidual coal. With alkalis it forms neutral cryſtallizable ſalts, and inſoluble ſalts with alkaline earths. Its action upon metals is but ſlight. It is conſidered by modern Chemiſts as an acid of its own kind, termed the ſaccholactic acid.

§ DCCCCXXIII. The ſugar of milk is, therefore, a ſubſtance compoſed of the baſes of two acids, one of which, combined with oxygen, forms the ſaccholactic acid; but the other ſeems to be ſugar changed into acid of ſugar, in conſequence of its union with the acidifiable principle.

§ DCCCCXXIV. The ſerum of milk, when at reſt, ſpeedily undergoes the acid fermentation; therefore, by the addition of a ſmall portion of ſpirit of wine and ſubſequent fermentation, we may prepare a true vinegar of milk. The acid obtained ſimply by the fermentation of ſerum of milk is conſidered by many modern Chemiſts as an acid of a peculiar kind, which they call the Lactic acid. Others, on the contrary, are of opinion, that it is not different from the acetous acid. To obtain it in a pure ſtate, fermented whey is ſaturated with chalk, afterwards filtrated, and then affuſed with acid of ſugar till precipitation ceaſes. The lactic acid, thus ſet at liberty, is again filtrated and evaporated to the conſiſtence of honey, and finally mixed with three parts of alcohol, which diſſolves the lactic acid, and leaves the ſugar of milk. The alcohol being ſeparated, pure lactic acid remains, which is uncryſtallizable.

§ DCCCCXXV. The cheeſy part, or curd, is a white elaſtic ſubſtance, very liable to putrefaction. By diſtillation in the dry way, it affords an inſipid phlegm, hydrogen gaz, carbonic acid gaz, ammoniac, and a very fetid empyreumatic oil. The reſidue is a conſiderable quantity of coal, which is not incinerated but with great difficulty, and contains no pot aſh, but phoſphate and carbonate of lime. Cheeſe is inſoluble in water, and in hot water it becomes hard; but it is diſſolved by acids and cauſtic alkalis. Hence it is obvious that it approaches neareſt to vegetable gluten.

§ DCCCCXXVI. Curd, ſalted and compreſſed, forms common cheeſe. If the former be obtained from ſkimmed milk, it contains but little butter, and the cheeſe is meagre and bad; but if prepared from new milk, containing all its cream, the cheeſe is good and rich.

§ DCCCCXXVII. Butter freed from all its whey and cheeſy matter is ſoft, either white or yellowiſh, of a mild pleaſant taſte, and void of ſmell. It melts by a gentle heat, and becomes ſolid again when cooled. It affords by diſtillation a little inſipid water, an acid of a very pungent ſmell, viz. the ſebacic acid, and a fetid oil, the oil of butter. The reſidue conſiſts of a ſmall portion of animal carbon.

§ DCCCCXXVIII. At a temperature ſomewhat higher, the ſebacic acid is ſpontaneouſly ſeparated from butter, which thus acquires an acrid ſmell and taſte; it is then ſaid to be rancid. This fault is partly corrected by waſhing the butter in alcohol, which takes up the ſebacic acid. Butter, united with alkalis, forms a true ſoap. From all theſe circumſtances it is evident that butter is very little different in its chemical properties from the fat oils of the vegetable kingdom.

§ DCCCCXXIX. Milk, therefore, conſiſts properly of a fat oil and of a particular gluten, which are imperfectly diſſolved in water, by means of a ſaccharine ſubſtance, forming a kind of animal emulſion.

§ DCCCCXXX. If milk, juſt taken from the cow, be put into a warm place, and the ſeparation of the butter and cheeſe from the whey be prevented by repeated agitation, the fermentation of the whey will proceed much ſlower, and the period of the ſpirituous fermentation is much more determinate; ſo that by the diſtillation of ſuch milk, we may obtain true alcohol. Yeſt, when added, promotes the fermentation of milk, in the ſame manner as that of vegetable juices. It is probable that the quantity of alcohol afforded by milk is greater the more ſugar of milk it contains.

§ DCCCCXXXI. Milk, from whatever animal it may be obtained, conſiſts of the principles above mentioned, but not always in the ſame proportion. The difference between cow's milk and that of other animals is as follows;

§ DCCCCXXXII. The milk of every animal has a peculiar aromatic ſmell; ſo that a ſkilful perſon may know whether it be the milk of the female of the human ſpecies, of cows, goats, mares, or aſſes; beſides, all milk affords cream; but that of ſheep and goat's milk is much thicker: that of the milk of the human female, on the contrary, and of aſſes and mares, is thinner and leſs abundant.

§ DCCCCXXXIII. Butter is ſeparated with equal facility from goat's milk as from cow's milk; it is ſolid, and cannot be remixed with the remaining milk. The butter obtained from the milk of ſheep is ſoft.—Finally, butter is inſeparable from the milk of aſſes, mares, or the human female, or at leaſt only in the ſtate of cream, and is readily diſſolved in the remaining milk by the aid of heat.

§ DCCCCXXXIV. The cheeſy part of goat's milk, like that of cow's milk, is ſolid and elaſtic; that of aſs's and mare's milk is leſs ſolid; and that of ſheep's milk glutinous only. The cheeſy part of women's milk is never ſolid, but always fluid; and its ſeparation is attended with difficulty, and ſeldom ſpontaneous.

§ DCCCCXXXV. The aroma is always contained in the whey, which has, on that account, both a peculiar taſte and ſmell, according to the animal from which it is obtained. The milk of women, aſſes, and mares, contains much ſerum; goat's and cow's milk leſs, and ſheep's milk the leaſt.

§ DCCCCXXXVI. The ſugar of milk is always the ſame ſubſtance from whatever animal it is obtained; but all milk does not contain the ſame quantity of it. Next to mare's and aſs's milk, that of the human female contains it in the greateſt abundance.

§ DCCCCXXXVII. If other neutral ſalts be preſent in milk, they are merely adventitious, and depend, in a great meaſure, upon the food of the animal. Thus cow's milk contains ſometimes the muriates of pot-aſh and lime.

§ DCCCCXXXVIII. From what has been ſaid of the different properties and proportions of the conſtituent parts of milk of various animals, we are enabled, in ſome meaſure, to account for many of the properties of milk. Thus, why does the milk of the human female keep longeſt without becoming acid? Becauſe the butter and cheeſy part are not ſo readily ſeparated, and, by combining with the ſerum, the latter is prevented from fermenting. Why does mare's milk produce more vinous ſpirit than cow's milk during fermentation? Becauſe it contains more ſugar of milk, &c.

§ DCCCCXXXIX. Theſe ſeveral properties of milk differ alſo in degree, according to the diet which the animal uſes. And this circumſtance is of conſiderable importance, eſpecially with reſpect to the milk of women; for what we have hitherto mentioned of this milk is ſtrictly true then only, when the woman who produces it uſes a mere animal diet, or, at leaſt, a common diet of animal and vegetable ſubſtances: for the milk of a woman, who lives on vegetable diet only, approaches very nearly to cow's milk, affords leſs cream, becomes ſour in a ſhorter time, and is ſooner and more perfectly coagulated by acids and other agents.

CXVIII. OF BLOOD.

§ DCCCCXL. Blood varies not only in different animals, but even in the ſame animal, according to the different parts of the body. Thus we know that the blood of ſome animals is of the common temperature of the atmoſphere, whilſt that of others is conſiderably hotter; that the colour of arterial blood, on account of its abſorption of oxygen, is deeper than that of the veins, and ſo on. But all theſe diſtinctions are not yet ſufficiently aſcertained; therefore the analyſis of blood, recently taken from the vein of an adult and healthy perſon, may ſuffice for the preſent.

§ DCCCCXLI. This blood is of a deep red colour, thick, and ſomewhat ſaline. On cooling, when at reſt, it becomes at firſt a perfect coagulum, but ſoon after it begins to ſeparate into two parts. One of theſe, which is red and ſolid, is termed the coagulum, or clot; the other, a yellow liquid, is called ſerum, or lymph.

§ DCCCCXLII. Blood readily putrefies in a moderate temperature. By a gentle heat it dries into a black maſs, termed the extract of blood. When diſtilled without addition, it affords an inſipid phlegm, which quickly putrefies, an empyreumatic oil, and a neutral ammoniacal ſalt, conſiſting of an empyreumatic acid, which has not yet been ſufficiently examined, ſuperſaturated with ammoniac. During this operation, the blood becomes very intumeſcent, evolves much hydrogen and carbonic acid gaz, and leaves a very ſpongy coal, which is difficultly reduced to aſhes, conſiſting of common ſalt, ſoda, and phoſphate of lime.

§ DCCCCXLIII. The ſerum is a greeniſh yellow liquor, of an adheſive conſiſtence, and ſomewhat ſaline to the taſte. It is almoſt entirely coagulated by heat before it boils. When diſtilled on the water-bath, it affords an inſipid phlegm, and the coagulum remains. When urged by a ſtronger fire, it greatly intumeſces, and produces carbonic acid gaz, liquid volatile alkali, much mild ammoniac, and a thick empyreumatic oil; a large reſidual coal is obtained, which is with difficulty reduced to aſhes, containing common ſalt, carbonate of ſoda, and phoſphate of lime.

§ DCCCCXLIV. The ſerum combines in any proportion with cold water, and without change; but when thrown into hot water, it inſtantly coagulates. Though a part of it combine with the water and form a milky liquor, yet it may be again ſeparated by protracted ebullition, or the addition of alcohol. Mineral-acids alſo render ſerum concrete, and, if the coagulated part be then ſeparated by filtration, we obtain, from the remaining evaporated liquid, the neutral ſalt which ariſes from the union of the acid and ſoda, although but in ſmall quantity. Serum is, in like manner, coagulated by concentrated vegetable acids, but alkaline ſalts only tend to dilute it.

§ DCCCCXLV. Coagulated ſerum is inſoluble in water. By a moderate heat it dries into a corneous maſs. It is ſoluble as well in concentrated mineral acids as cauſtic alkalis. The former ſolutions are decompoſed by water, and the latter by acids. This ſubſtance, upon the whole, is very ſimilar to the cheeſy part of milk. When coagulated ſerum is treated with diluted nitric acid, at a higher temperature, nitrous and azotic gaz will be obtained, and acid of ſugar, beſides a ſmall portion of malic acid, is generated in the reſiduum.

§ DCCCCXLVI. It appears from the preceding experiment, that ſerum of blood conſiſts of water, coagulable lymph, a ſmall portion of gluten, culinary ſalt, carbonate of ſoda, and phoſphate of lime. The animal gluten is the acidifiable baſis, which may be changed into malic and oxalic acids; but the coagulable lymph is the body which, by dry diſtillation, affords oil, and is chiefly diſtinguiſhed, on account of its property, of becoming ſolid by heat.

§ DCCCCXLVII. The clot, or coagulum, of blood gradually dries by a gentle heat, and becomes brittle; but it putrefies very ſpeedily if the atmoſphere be warm. When waſhed in cold water it ſeparates into two parts, one of which diſſolves in the water and communicates to it the red colour, and the other part is a white fibrous ſubſtance, termed the fibrous part of the coagulum.

§ DCCCCXLVIII. The water, thus tinged by the coagulum, contains, in reality, all the colouring matter of blood. When chemically examined, it proves to be the ſame as the ſerum, except that it contains a great deal of iron. This may be ſeparated by incineration, when, by waſhing the aſhes, it remains in the form of a brown calx. This circumſtance has induced ſome phyſiologiſts to aſcribe the red colour of blood to the iron.

§ DCCCCXLIX. The fibrous part of blood is perfectly taſteleſs, and inſoluble in water or alcohol. When boiled in water, or otherwiſe expoſed to a moderate heat, it becomes hard, and if this be ſuddenly done, it ſhrinks up like parchment. The cauſtic fixed alkalis diſſolve it only by the aid of ebullition, and cauſtic ammoniac has no effect upon it whatever. Acids diſſolve it with diſengagement of nitrous and azotic gaz; the nitric acid alſo generates malic and oxalic acids. The alkalis precipitate it from theſe ſolutions in a changed ſtate. It putrefies very readily in a moiſt atmoſphere. It affords, by dry diſtillation, much ærated ammoniac, a very fetid empyreumatic oil, and a coal which is eaſily reduced to aſhes, and contains neither ſoda nor neutral ſalts, but pure lime and phoſphate of lime only.

§ DCCCCL. The fibrous ſubſtance is partly ſeparated in the blood of horſes and in the human blood in inflammatory diſeaſes, covering the clot in the form of a yellowiſh tough cuticle, commonly called the buffy coat of the blood.

§ DCCCCLI. If blood, ſuch as it comes from a vein, be put into a veſſel void of air, or filled with an unreſpirable gaz, it alſo coagulates, but not ſo ſpeedily, nor to that extent, as in atmoſpheric air, and the colour of the coagulum is rather black than red. On the contrary, if recent blood be put into a veſſel containing oxygen gaz, the coagulation proceeds rapidly, and the colour of the coagulum is as red as it would be in atmoſpheric air.

§ DCCCCLII. If the red coagulum of blood, formed in the open air, be put into a veſſel containing inflammable gaz, a gradual diminution of the gaz is obſerved, and the coagulum is deprived of its red colour, becomes purple, and ultimately black. But, on expoſing this black coagulum, or ſuch as is formed in a vacuum, or a veſſel filled with unreſpirable air, to the atmoſphere, or, which is preferable, to pure oxygen gaz, the vermilion colour of the clot returns, the quantity of oxygen gaz diminiſhes, and a ſmall portion of carbonic acid gaz is formed.

§ DCCCCLIII. If blood, recently taken from a vein, which we know to be either purple or black, be impregnated with oxygen gaz, it will obtain a vermilion colour, which, however, gradually diſappears and becomes again purple, and laſtly black. It is liable to the latter change, though it continue in contact with oxygen gaz; nor can any new impregnation with it render it again red. On the contrary, if arterial blood, which is of a light colour, come into contact with an unreſpirable gaz, its colour is gradually changed to purple.

§ DCCCCLIV. If oxygenated muriatic acid be poured into venal blood, recently obtained, the blood inſtantly aſſumes a black colour. Common muriatic acid, of the ſame ſtrength as the oxygenated, produces no change of colour; if it be concentrated, it cauſes it to coagulate very ſpeedily without tinging it black.

§ DCCCCLV. Theſe important experiments have induced modern Phyſiologiſts and Chemiſts to draw the following concluſions:

1. The black venal blood (§ DCCCCLIII.) combines with the hydrogen gaz, diſſolves it, and derives from it its red colour. oxygen

2. The oxygen gaz, now in a ſtate of combination with the red blood, is gradually decompoſed, the oxygen combining more intimately with the carbon and hydrogen of the blood individually, forms water and carbonic acid, whence the blood becomes again black, (§ DCCCCLIII.) The latter change ſucceeds more rapidly in unreſpirable air than if the blood were expoſed for ſome time to oxygen gaz. The cauſe of its combining with this gaz is, that,

having loſt its ſuperabundant hydrogen and carbon, it appears no longer to have an affinity with oxygen gaz.

§ DCCCCLVI. It is further concluded, that the phenomena which occur in the reſpiration of animals are perfectly analogous to thoſe obſerved in the preceding experiments. The oxygen gaz inſpired combines with the venal blood returned to the lungs, partly with the whole, and partly with its hydrogen and carbon individually, forming water and carbonic acid, which are expired. And the combination of the oxygen gaz with the remainder of the black venal blood produces the red arterial blood, in which, during the circulation, the union of the vital air with the carbon and hydrogen is gradually extended, and, at length, having attracted a new portion of hydrogen and carbon, and become black, it returns to the lungs through the veins.

§ DCCCCLVII. Hence the caloric of the oxygen gaz is not entirely diſengaged in the lungs, but only in part, and even this does not remain in the ſtate of ſenſible heat, as it immediately tends to change the carbonic acid and water into the gazeous ſtate. The greater part of the caloric contained in the oxygen gaz is, therefore, liberated and diſengaged as ſenſible heat during the circulation of the blood, in conſequence of the gradual combination of the oxygen with the ſuperabundant carbon and hydrogen. It is this ſenſible heat which, by its uniform and uninterrupted diffuſion through the whole body, contributes moſt to produce in it that temperature which is termed animal heat.

This theory enables us to account for the greater ſpecific heat in arterial blood than in venal blood, beſides various other phyſiological and pathological phenomena.

§ DCCCCLVIII. According to ſome Chemiſts, when the dark venal blood, impregnated with hydrogen and carbon, is returned to the lungs, it decompoſes the oxygen gaz, and, in conſequence, throws off its ſuperabundant carbon and hydrogen in the form of water and carbonic acid gaz, which are expired. The caloric, thus liberated, is not entirely diffuſed in the ſtate of ſenſible heat, becauſe it inſtantly combines with the red arterial blood, which, on account of its greater capacity for heat, requires much more to preſerve the ſame temperature. The blood, thus enriched with a greater quantity of ſpecific heat, now diffuſes itſelf through the whole body, but, acquiring in its circulation a new portion of carbon and hydrogen, its capacity for heat is gradually diminiſhed, and, conſequently, it parts with a proportionate quantity of caloric, till it returns to the lungs.

CXIX. OF THE PRUSSIC ACID.

§ DCCCCLIX. If the extract of blood and a fixed alkali be gradually heated till the mixture becomes red hot, and then ſeparated, by waſhing, from the coal, we find that the alkali has obtained all the properties of a neutral ſalt; for a peculiar acid, termed the pruſſic acid, is formed during the combuſtion of the blood, which combines with the alkali, and produces the neutral ſalt above mentioned, which is alſo called phlogiſticated alkali; this ſubſtance may be prepared, in the ſame manner, from bones, hair, and various other animal parts.

§ DCCCCLX. This neutral ſalt has a yellow colour, and a peculiar ſmell. It does not effervеſce with acids, nor does it change the colour of violets; it is incapable alſo of decompoſing earthy neutral ſalts. But all metals diſſolved in acids are precipitated by it; the alkali combines with the acid of the metallic ſalt, and the calx itſelf with the pruſſic acid, which communicates to it a peculiar colour; thus the precipitate of iron appears dark blue, that of copper brown red, of lead white, and of gold yellow.

§ DCCCCLXI. If phlogiſticated alkali be ſlowly evaporated, it affords cubic and tetraëdral columnar cryſtals of a yellow colour, which, according to the alkali made uſe of, are termed pruſſiate of pot-aſh or ſoda.

§ DCCCCLXII. The iron precipitated from a ſulphuric acid ſolution by phlogiſticated alkali is termed pruſſian blue, or, chemically, pruſſiate of iron; from which the pruſſic acid may be ſeparated by digeſtion with cauſtic alkalis; pruſſiate of alkali in that caſe is obtained, and the iron remains in the ſtate of a brown oxide.

§ DCCCCLXIII. But, to have the pruſſiate of alkali perfectly pure, it is ſaturated with diſtilled vinegar evaporated to the conſiſtence of honey, and combined with three parts of alcohol. This body diſſolves the acetite of pot-aſh, in conſequence of which pruſſiate of pot-aſh falls to the bottom in the form of ſmall ſcales.

§ DCCCCLXIV. To obtain the pruſſic acid in a pure ſtate, ſulphuric acid is added to phlogiſticated alkali or cryſtallized pruſſiate of alkali, till it ſuperabounds. The mixture being then diſtilled by a gentle fire from a retort with Woulfe's apparatus, the pruſſic acid is diſengaged in the form of gaz, and abſorbed by the water of the receiver. It is likewiſe obtained by the diſtillation of blood with nitric acid.

§ DCCCCLXV. The pruſſic acid has an acrid taſte, and a ſuffocating ſmell, ſimilar to that of bitter almonds; but, except its capacity of combining with alkalis and metals, it ſhews no acid property.

§ DCCCCLXVI. The pruſſic acid readily combines with ammoniac, and, by digeſting pruſſiate of iron in ammoniac, we obtain pruſſiate of ammoniac. Moſt of the properties of this ſalt are ſimilar to thoſe of common pruſſiate of alkali; if it be diſtilled by a moderate heat, the whole comes over unaltered. Pruſſiate of lime, in like manner, is prepared by the digeſtion of lime-water with pruſſiate of iron. This neutral ſalt is decompounded by the cauſtic alkalis, which combine with the pruſſic acid.

§ DCCCCLXVII. The pruſſic acid occurs not only in the animal kingdom, but alſo in the mineral kingdom, combined with iron; and we obtain it from vegetable ſoot, when treated with alkalis.

§ DCCCCLXVIII. The baſis of the pruſſic acid is obviouſly compound, but its conſtituent parts are as yet obſcure, and the opinions of Chemiſts, on this ſubject, differ; ſome are of opinion that its baſis is compoſed of hydrogen, nitrogen, and carbon; others, on the contrary, conſider phoſphorus as one of its principles.

CXX. OF BILE.

§ DCCCCLXIX. Bile, or gall, is a tenacious humour, more or leſs of a yellowiſh green colour, a bitter taſte, and nauſeous ſmell, ſeparated from the blood in the large viſcus called the liver. In ſome animals this fluid, even freſh, poſſeſſes an agreeable odour, ſimilar to that of muſk; but, in others, it only obtains this property by evaporation or age.

§ DCCCCLXX. Bile ſuffers no alteration by repoſe, but it putrefies when it becomes old, or is expoſed to heat. If it be diſtilled on the water-bath, we obtain an inſipid phlegm, which has frequently the odour of amber, and is very liable to putrefaction. The reſiduum is a dry brittle greeniſh maſs, termed extract of bile, which affords by dry diſtillation a volatile alkaline liquid, dry mild ammoniac, and a fetid empyreumatic oil. During this proceſs the maſs ſwells conſiderably, and there remains a large ſhining coal, which is eaſily reduced to aſhes, and conſiſts of ſoda, phoſphate of lime, and iron.

§ DCCCCLXXI. Bile, as well as the extract of it, is inſoluble in water. It is decompoſed by mineral acids and vinegar, which diſengage a coagulated maſs, ſimilar to the coagulated ſerum of blood, or the cheeſy part of milk. This precipitate is ſoluble in an exceſs of acid, and forms with the muriatic acid a red ſolution. On evaporating the remaining liquid, we obtain a neutral ſalt, compoſed of the acid employed and ſoda.

§ DCCCCLXXII. Bile is decompoſed by alcohol, in the ſame manner as by acids; but, if after the coagulum is ſeparated, the remaining tincture of bile be evaporated by a moderate heat, a reſinous balſamic ſubſtance is obtained, which, with the exception of a ſmall quantity of gluten, is completely ſoluble again in alcohol; and which, diſſolved in alkalis, forms green ſolutions. When diſtilled by itſelf, the products are a yellowiſh bitter phlegm; a thick empyreumatic oil, ſimilar to balſam; and an inconſiderable portion of ammoniac. The reſiduum is a black maſs which reſembles reſin.

§ DCCCCLXXIII. Bile cannot be mixed either with etherial or fat oils, or butter, nor does it render thoſe bodies ſoluble in water. It ought not, therefore, to be conſidered as ſoap, and if we employ it with ſucceſs for removing ſpots out of cloth, the reaſon is, that the bile has a greater affinity with the cloth than the fat oils, which, conſequently, are diſengaged, and iſſue in drops.

§ DCCCCLXXIV. From the preceding experiments it is obvious, that bile conſiſts of a coagulable lymph, reſinous matter, animal gluten, ſoda, and particles of iron. The proportion of the latter, however, is but ſmall; nor is it decided whether soda exiſts in bile in a free state.

§ DCCCCLXXV. If from ſome cauſe or other the bile remain too long in the gall-bladder, it depoſits ſmall ſolid maſſes of a brown colour, and for the moſt part of a radiated texture, termed biliary calculi. In ſome animals, they are almoſt always to be found at certain periods of the ſeaſon. They are of two kinds; ſome are ſoluble in ſpirit of wine, oil and ſoap, and the ſolution by the former affords an acidulous ſalt in the form of thin laminæ. Others, on the contrary, conſiſt, it is ſaid, of this ſalt only. According to the opinion of moſt Chemiſts, biliary calculi are nothing but bile concreted by abſorbing oxygen, which opinion is apparently confirmed by the circumſtance, that bile may be changed into a ſimilar ſubſtance by the oxygenated muriatic acid.

CXXI. OF THE GASTRIC JUICE.

§ DCCCCLXXVI. The gaſtric juice is a humour ſecreted in the ſtomachs of animals for the purpoſe of digeſting the nutriment. It differs in every ſpecies of animal according to the nature of their food and the ſtructure of their ſtomachs; thus in gallinaceous birds it changes the aliment merely into a pultaceous maſs, after having been properly prepared by the muſculous ſtomach of the bird; in rooks and crows, on the contrary, it acts already by itſelf. It requires a ſimilar preparation in ruminating animals; but, in amphibious animals and birds of prey, it does not ſtand in need of it. In amphibious animals and fiſhes it digeſts the nutriment at the common temperature of the atmoſphere; but, in lactiferous animals and birds, it requires a higher temperature. Its action in the former is ſlower, in the latter quicker. Its agency in ſome animals is confined to vegetable matter alone, in others it acts excluſively upon animal ſubſtances; and in ſome it produces an effect upon both. Finally, the gaſtric juice of ſome animals is capable of digeſting the hardeſt bones, without any mechanical co-operation, tendons, or ligaments, which action is continued even after the death of the animal.

§ DCCCCLXXVII. The gaſtric juice is inodorous and of a ſaline taſte. It is not liable to ſpontaneous fermentation or putrefaction, and it even prevents other bodies from undergoing theſe changes when mixed with it. It tinges the infuſion of violets red. It combines with water in any proportion. Neither acids nor alkalis cauſe it to coagulate. With ſpirit of wine it affords a gelatinous precipitate. It coagulates milk, but produces no effect whatever upon blood. But the gaſtric juice of adult ruminating animals differs from theſe properties in as much as it readily putrefies, changes the juice of violets green, and is incapable of coagulating milk.

§ DCCCCLXXVIII. It appears alſo that the gaſtric juice of different animals does not exhibit the ſame phenomena when diſtilled in the dry way. In general, however, it comes over for the moſt part as an inſipid phlegm, which is neither acid nor alkaline, and affords but a very ſmall portion of empyreumatic oil. The reſiduum is a ſaline maſs, frequently compoſed of common ſalt, ſal ammoniac, and a ſmall quantity of coal. We rarely obtain the volatile alkali.

§ DCCCCLXXIX. It is evident, from the preceding experiments, that the chemical decompoſition of the gaſtric juice does not enable us to account for all the ſingular phenomena produced by its influence upon digeſtion. It appears to be principally compoſed of water, animal gluten, and ſalts.

CXXII. OF TEARS.

§ DCCCCLXXX. The fluid ſecreted by the lacrymal glands, and which, when contained in abundance, flows through the noſtrils, and over the lower eyelids, upon the cheeks, viz. tears, is, in a ſtate of purity, limpid and inodorous, but very ſaline, and changes the juice of violets green.

§ DCCCCLXXXI. If tears be expoſed to atmoſpheric air, or a gentle heat, they dry into a yellow ſubſtance, in which we frequently diſtinguiſh cubic cryſtals. This dried ſubſtance, when diſtilled by a ſtronger heat, affords a ſmall quantity of water and empyreumatic oil, beſides a coal, of which the aſhes contain common ſalt, a ſmall portion of ſoda, and phoſphates of lime and of ſoda.

§ DCCCCLXXXII. Recent tears are perfectly ſoluble in water, but their ſolution is ineffectual if they be kept for ſome time in the open air, or be dried. Freſh tears are diluted by alkalis, which even diſſolve thoſe that are dry. Alcohol cauſes them to coagulate, and ſeparates their mucilage. By the evaporation of the remaining alcohol we obtain common or culinary ſalt and ſoda.

§ DCCCCLXXXIII. The action of the ſulphuric and muriatic acids upon recent tears is very ſlight, but dry tears are diſſolved in them with effervеſcence. In the former caſe muriatic acid and carbonic acid gaz are developed, and ſulphate of ſoda remains behind. But, in the later caſe, only carbonic acid gaz is ſeparated, and the reſidue is completely ſaturated ſoda. That change which tears undergo but ſlowly in atmoſpheric air is inſtantly produced upon them by the oxygenated muriatic acid.

§ DCCCCLXXXIV. It is obvious from theſe experiments, that tears are chiefly compoſed of water, a peculiar kind of mucilage, common ſalt, phoſphate of lime, phoſphate of ſoda, and ſoda in a free and apparently cauſtic ſtate; becauſe recent tears have no effect upon lime-water, whereas dried ones render it turbid. The change which tears undergo during their exſiccation depends, probably, upon a true abſorption of oxygen and carbonic acid.

CXXIII. OF MUCUS.

§ DCCCCLXXXV. By this name we diſtinguiſh that humour which, eſpecially in catarrhs, flows abundantly through the membrane of ſchneider into the noſtrils. At firſt it is clear, tranſparent, inodorous, and of an acrid ſaline taſte. In this ſtate its chemical properties are analogous to thoſe of tears; but, if it remain ſome time in the noſe, it becomes opaque, yellow, tenacious, inſoluble in water, and ultimately a dry yellowiſh green ſubſtance.

§ DCCCCLXXXVI. We have reaſon to believe that this change is chiefly produced by the oxygen, which the mucus abſorbs from the great quantity of air inſpired through the noſe. The carbonic acid of the air expired alſo ſaturates the free ſoda; and it is probable that this change, which is inſtantly produced by the inſpiration of the oxygenated muriatic acid, is greatly promoted by the increaſed temperature of the fever in violent catarrhs.

CXXIV. OF SALIVA.

§ DCCCCLXXXVII. The ſaliva is ſeparated from the blood of animals in the ſalivary glands, and carried by different ducts to the mouth, where, by mixing with the nutriment during maſtication, it either renders it fit for digeſtion, or diſſolves it to excite its irritable power upon the tongue. Saliva, in a pure and healthful ſtate, is a ſpumy, colourleſs, inſipid, inodorous humour, which ſpeedily putrefies on expoſure to a warm atmoſphere.

§ DCCCCLXXXVIII. When recent it does not change the colour of ſyrup of violets, nor does it in other reſpects indicate the leaſt property of a free acid or alkali. It is pretty well diſſolved in water. Alcohol cauſes it to coagulate. It does not enter into combination with fat oils.

§ DCCCCLXXXIX. It coagulates when combined with a ſmall proportion of acids, but a greater quantity of acid diſſolves it. It is alſo diſſolved by mild alkalis, but cauſtic alkalis and quicklime ſeparate a ſmall portion of ammoniac from it.

§ DCCCCXC. Saliva affords, by diſtillation on the water-bath, an inſipid and inodorous phlegm, which amounts to more than four-fifths of the ſaliva, and is very liable to putrefaction. The reſiduum is a white ſhining brittle maſs, from which, by a ſtrong fire, we obtain the uſual products of animal bodies.

§ DCCCCXCI. Although the experiments hitherto made on ſaliva do not furniſh us with an accurate knowledge of its conſtituent parts, yet, from what we know, it is probable that in this reſpect it agrees for the moſt with mucus, and that it chiefly differs from this body in containing a greater quantity of water.

CXXV. OF PUS.

§ DCCCCXCII. Pus is a yellowiſh white humour, thick, unctuous, and opaque, generated in every part of the animal body by a peculiar preternatural change. It cannot, therefore, be conſidered as a conſtituent part of a healthful animal body, but it is ſo very ſimilar to mucus, in appearance, that not unfrequently we find it difficult to diſtinguiſh one from the other.

§ DCCCCXCIII. Pus, when freſh, and of a good quality, is inodorous and mild to the taſte. It produces no change upon the juice of violets, nor does it, in other reſpects, indicate the preſence of a free acid or alkali. On expoſure to a moderate temperature, it ſpeedily undergoes the acid fermentation, and reddens the tincture of violets and of the ſunflower. Finally, this acid pus putrefies, eſpecially in the open air; ammoniac is then developed, and a fetid liquor remains. Pus frequently undergoes theſe two changes in the animal body.

§ DCCCCXCIV. Pus is inſoluble in water, and, when rubbed or agitated with it, it forms ſimply a milky fluid, from which the pus is diſengaged by reſt. Though alcohol cauſes it to coagulate, by depriving it of its water, yet it is by no means diſſolved, nor have fat oils any greater effect upon it; but it may be combined in any proportion with animal jelly, mucus, and ſerum of blood.

§ DCCCCXCV. Diluted mineral acids act but ſlightly upon it, but concentrated acids diſſolve it. Theſe ſolutions are decompoſed on the addition of water, when the pus, ſcarcely changed, is precipitated. According to Bergmann it is inſoluble in mild alkalis. With the cauſtic alkalis it forms a tenacious gelatinous liquid, from which the pus may be diſengaged by acids.

§ DCCCCXCVI. It affords, by diſtillation on a water-bath, an inſipid inodorous phlegm, and a browniſh inſpiſſated matter remains. When treated by a ſtronger heat, we obtain the common products of animal ſubſtances.

§ DCCCCXCVII. The proximate principles of pus cannot be determined from the experiments juſt related, and remain, therefore, as yet unknown. It is obvious, likewiſe, how difficult it is to diſcriminate juſtly between mucus and pus. The latter, however, has this diſtinguiſhing property, that it undergoes the acid fermentation, while the former becomes putrid.

§ DCCCCXCVIII. To confirm and determine the diſtinction between pus and mucus, which was firſt noticed by Salmuth, Mr. Graſmeyer has lately propoſed the following experiment. The ſubſtance to be examined is mixed by trituration with an equal part of tepid water, a ſaturated ſolution of perfectly ærated pot-aſh, equal in weight to the ſubſtance, is then added, and the mixture is gently agitated and put aſide. Now, if the mixture under examination be pus, or mixed with it, it will diſengage at leaſt, in the courſe of a few hours, a tranſparent tenacious jelly; on the contrary, if the mixture contain no pus, it will remain unchanged.

CXXVI. OF SEMEN.

§ DCCCCXCIX. The ſemen of a man in health, at the moment it iſſues from the body, appears under a two-fold form; one part is a milky liquid, the other a thick tenacious mucilaginous ſubſtance. It has a peculiar ſmell, and its taſte is acrid and irritating. When perfectly freſh, it changes the juice of violets green, and decompoſes earthy and metallic ſalts.

§ M. As ſoon as the ſemen, after its diſcharge, has acquired the temperature of the atmoſphere, it becomes more opaque, and obtains a greater degree of conſiſtence; but, in the courſe of a few hours, its fluidity returns, and it becomes even clearer and more fluid than before. As its weight is not increaſed, this change is neither owing to the attraction of humidity, nor the abſorption of oxygen.

§ MI. A few days after it has undergone this change, it depoſits partly tranſparent rhomboidal and partly opaque foliated cryſtals, which are both phoſphate of lime. The ſemen, at the ſame time, becomes thick, and at length dries into a corneous ſubſtance.

§ MII. Semen, when freſh, is perfectly inſoluble in water; but, after it has undergone the change above mentioned, it combines with it with facility. This ſolution is promoted by alkalis, but alcohol and the oxygenated muriatic acid again ſeparate the ſemen in the form of white flocculi.

§ MIII. By the diſtillation of ſemen we obtain a ſmall portion of empyreumatic oil, ammoniac, and a reſidual coal, of which the aſhes contain ſoda and phoſphate of lime. Semen is ſoluble in all acids, except the oxygenated muriatic acid, which coagulates it in white flocculi.

§ MIV. The conſtituent parts of ſemen, as appears from the preceding experiments, are water, animal mucilage, ſoda, and phoſphate of lime, and in the following proportion: 100 parts of ſemen contain 90 parts water, 6 parts mucilage, 1 part phoſphate of lime, and 3 parts of pure lime. But this knowledge of the conſtituent parts of ſemen does not enable us by far to account for every one of thoſe remarkable phenomena which we obſerve in it.

CXXVII. OF FAT.

§ MV. Fat, as to its conſiſtence and colour, differs not only in various ſpecies of animals, but even in the ſame animal, according to the part of the body from which it is obtained. Thus, in general, the fat of amphibious animals and fiſhes is nearly fluid; and in fructivorous animals it is more ſolid than in thoſe which live upon fleſh. The fat under the ſkin and near the kidneys is alſo more ſolid than that of the bowels. In adult animals it is more ſolid than in young ones, &c. It has different names according to its external appearance, and the part and ſpecies of the animal from which it is taken; thus we have lard, marrow, whale-oil, ſpermaceti, &c.

§ MVI. The chemical properties of animal fat, purified from all heterogeneous matter, are perfectly analogous to thoſe of expreſſed vegetable oils. It is inodorous and of a mild taſte. It melts by a gentle heat, and is inſpiſſated when cooled. It becomes rancid by age, and forms ſoaps with cauſtic alkalis.

§ MVII. If fat be diſtilled from a retort, it becomes highly intumeſcent, and we obtain an acidulous phlegm, an empyreumatic oil, and a very conſiderable quantity of hydrogen and carbonic acid gaz; the reſiduum is a ſhining coal, not eaſily incinerated, the aſhes of which contain pure lime and phoſphate of lime. The oil obtained in this manner is of greater conſiſtence, and, like vegetable empyreumatic oils, is rendered more fluid, more colourleſs, and ſimilar to volatile oils by repeated diſtillation. When perfectly limpid, it is termed Dippel's animal oil.

§ MVIII. This oil is obtained more readily by diſtilling the brown oil over a gentle fire, or mixed with water; but, in introducing the oil into the retort, the operator ſhould be careful that no part of it adheres to the neck. This oil cannot, however, be long preſerved, for, unleſs the veſſel be very well cloſed, it loſes its whiteneſs in a ſhort time.

§ MIX. The acid obtained during the firſt diſtillation of the oil, and alſo during its rectification, differs eſſentially from all the reſt; whence it is termed the ſebacic acid. In order to obtain it in a purer and more concentrated ſtate, we ſaturate it with pot-aſh, and calcine the ſalt, thus produced, till all adhering fat is conſumed. We then add half its weight of ſulphuric acid, and re-diſtil the mixture over a gentle fire, by which means the ſulphuric acid combines with the pot-aſh, and pure ſebacic acid flows into the receiver.

§ MX. The ſebacic acid may alſo be ſeparated from fat directly, which proves that it exiſts in it ready formed. For this purpoſe melt fat or tallow by a gentle heat, ſtir it, and add a third of its weight of quicklime, which thus combines with the ſebacic acid. The maſs is then boiled in a conſiderable quantity of water to diſſolve the neutral ſalt formed by the ſebacic acid and the quicklime, which being done, the remaining fat and the quicklime not diſſolved are ſeparated by filtration. Finally, after the lixivium is evaporated to dryneſs, the ſalt obtained is ſlightly calcined and diſtilled (§ MIX.) with ſulphuric acid.

§ MXI. Pure ſebacic acid, combined with alkalis and alkaline earths, forms neutral ſalts not unlike thoſe of the acetic acid. It diſſolves pure gold, and beſt when in the ſtate of oxide, forming a cryſtallizable metallic ſalt with it. Its effect upon ſilver and mercury is the ſame. It precipitates lead from the nitric and acetic acids, and tin from aqua regia. When treated with alcohol it forms true ſebacic ether.

§ MXII. From what precedes, it is obvious that the different kinds of animal fat may be conſidered as true acid ſoaps (§ DCCLIV.) compoſed of the ſebacic acid and fixed animal oil. The ſebacic acid may be changed into the acid of ſugar by treating it with the nitric acid.

§ MXIII. To the different ſpecies of animal fat, we may add cerumen and civet; the former is probably a true fat, rendered bitter and rancid by the acceſs of air and heat. The diſtinguiſhing property of the latter is a ſtrong balſamic ſmell.

CXXVIII. OF EGGS.

§ MXIV. A bird's egg, when minutely examined, appears to conſiſt of five parts; 1, the ſhell; 2, the pellicle; 3, the white; 4, the bread; 5, the yellow or yolk. The ſhell is compoſed of calcareous earth and phoſphate of lime, united by an animal gluten. It is very difficult therefore to diſſolve an egg-ſhell directly in concentrated acids, but if theſe be diluted and digeſted upon it, the ſolution is perfect, and the gluten is ſeparated, and forms a diſtinct ſtratum.

§ MXV. White of egg agrees in its chemical properties with the ſerum of blood and the cheeſy part of milk. It changes the ſyrup of violets green, and putrefies in a ſhort time when left to itſelf. At the temperature of boiling water it becomes a gelatinous maſs, which, by a continued moderate heat, or in the open air, dries into a tranſparent corneous ſubſtance. If this operation be performed in cloſe veſſels, on a water bath, we obtain an inſipid phlegm which ſpeedily putrefies. When diſtilled by an intenſer heat, it affords carbonic acid gaz, hydrogen gaz, an empyreumatic oil, and ammoniac. The reſiduum is a coal, of which the aſhes contain phoſphate of lime and ſoda.

§ MXVI. White of egg, if recent, is ſoluble in water, but inſoluble when hard. It coagulates in all acids, and, if the coagulum be ſeparated by filtration, we obtain, on evaporating the remaining liquid, a neutral ſalt, formed of the acid employed, and ſoda; alcohol likewiſe coagulates the white of egg.

§ MXVII. The yolk conſiſts principally of white of egg, combined with a fixed animal oil and ſome jelly. Hence it is partly ſoluble in water, with which it forms a kind of vegetable emulſion. It hardens on expoſure to fire, but becomes merely a friable maſs, from which, when gently torrefied, we may expreſs the oily ſubſtance termed oil of eggs; which is ſimilar to an inſpiſſated fixed vegetable oil, but becomes rancid in a ſhort time. What remains after expreſſion is the coagulable part of the yolk. The yolk of eggs is partly coagulated by acids and alcohol. It affords by dry diſtillation the products of all animal bodies.

§ MXVIII. The pellicle or membrane of the egg agrees with the fibrous part of blood. As for the tread, it only differs from the white of egg by its greater conſiſtence.

CXXIX. OF THE WHITE AND SOFT PARTS OF ANIMALS.

§ MXIX. The ſkin, the cartilages, the tendons, the ligaments, the cellular membrane, the nerves, &c. are chemically conſidered the ſame; and it is probable that they differ from each other merely in their organic ſtructure. They are partly diſſolved when boiled in water; and, if this proceſs be extended till the water is rendered incapable of diſſolving any thing more, a fibrous ſubſtance, ſimilar to the fibrous part of blood, remains.

§ MXX. If the water in which the animal parts above-mentioned were boiled be evaporated, and afterwards cooled, it becomes an elaſtic tranſparent maſs, termed animal jelly or mucilage. But, if the evaporation be extended, the ſubſtance obtained is corneous, opaque, and brittle, called animal glue.

§ MXXI. Jelly, when pure and freſh, is inſipid and inodorous. It is incapable of burning, and, when left to itſelf, it becomes firſt acid, and ſhortly after putrid. It is inſoluble in alcohol, but water diſſolves it in any proportion. It affords, by diſtillation on a water-bath, an inſipid phlegm, and dry glue remains, which, when diſtilled by an intenſer heat on the ſand-bath, yields ammoniac and an empyreumatic oil. The reſiduum is a coal, which is with difficulty reduced to aſhes, containing common ſalt and phoſphate of lime. Jelly is perfectly ſoluble in acids and alkalis, and the nitric acid diſengages a great quantity of nitrogen gaz from it.

§ MXXII. The white and ſoft parts of animals conſiſt, therefore, principally of jelly and the fibrous part of blood. But jelly differs in ſolubility and colour, according to the part from which it is prepared.

CXXX. OF MUSCLES.

§ MXXIII. A muſcle or fleſh is mechanically compoſed, and conſiſts of a cellular membrane, whoſe interſtices are filled with ſolid and fluid parts, but ſo minutely divided that they cannot be ſeparated except by chemical means. Fleſh, it thus appears, conſiſts properly of a fibrous ſubſtance, jelly, white and red ſerum of blood, fat, a peculiar extractive matter, and ſalts.

§ MXXIV. Fleſh affords, by diſtillation on the water bath, an inſipid phlegm, which putrefies very ſpeedily; and it remains dry in the retort. When urged by a ſtronger fire, it yields an ammoniacal phlegm, an empyreumatic oil, and dry mild ammoniac. The reſiduum is a coal, the aſhes of which contain a ſmall portion of ſoda, and muriate of ſoda or pot-aſh.

§ MXXV. But, that the conſtituent parts of fleſh may be ſeparated and individually exhibited, we ſhould proceed in the following manner: the fleſh is waſhed in cold water as long as it affords any colouring matter, the remainder is then digeſted in alcohol, and thoroughly boiled in water. The firſt water receives the ſerum of blood, which may be coagulated and ſeparated by ſlow evaporation. The evaporation being protracted, we obtain part of the ſalts; the alcohol diſſolves the remaining ſalts, and the extractive matter. Finally, the jelly and fat are extracted during the laſt operation, when a mere muſcular fibre remains.

§ MXXVI. The properties of ſerum of blood, jelly, fat, and the fibrous ſubſtance are already known, but we are leſs acquainted with the extractive part of fleſh, as it is called. This ſubſtance is ſoluble both in alcohol and water; its taſte is acrid and ſomewhat bitter, and its ſmell aromatic, which increaſes when ſtrongly evaporated, and approaches at laſt to that of burnt ſugar, as we may obſerve on the outſide of roaſted meat. Our knowledge of the ſalts is equally limited and uncertain, though, from what we know, it appears probable that they chiefly conſiſt of phoſphate of lime and calcareous earth.

CXXXI. OF BONES.

§ MXXVII. Bones, horns, claws, and other ſolid conſtituents of red-blooded animals, conſiſt for the moſt part of jelly, a ſmall portion of fat, and an earthy neutral ſalt, compoſed of a peculiar acid, the phoſphoric acid, and calcareous earth. The jelly and fat may be obtained by boiling, in the ſame manner as from the white and ſoft animal parts; the earth in that caſe remains behind. The hartſhorn thus obtained was formerly termed *cornu cervi philoſophice preparatum.* This decoction of bones is beſt effected in a papinian machine.

§ MXXVIII. If bones be diſtilled by a ſtronger fire, without any additional body, we obtain, beſides a great quantity of hydrogen gaz and carbonic acid gaz, a volatile alkaline liquid, already combined in ſome meaſure with empyreumatic oil, likewiſe pure empyreumatic oil, and dry mild ammoniac. The reſiduum is a coal, which it is extremely difficult to incinerate. The alkaline liquid, obtained from hartſhorn as before mentioned, is termed by apothecaries ſpirit of hartſhorn, the alkaline ſalt, ſalt of hartſhorn, and the calcined reſiduum, burnt hartſhorn.

§ MXXIX. Bones, deprived of all jelly and fat by calcination, furniſh, when waſhed in cold water, a ſmall quantity of ſoda, and, if boiling water be uſed, alſo an inconſiderable portion of gypſum; what remains is phoſphate of lime only, from which the acid may be diſengaged in the following manner: three parts of diluted ſulphuric acid are affuſed upon four parts of pulverized aſhes of bones while continually ſtirred; by this means the ſulphuric acid combines with the calcareous earth, and diſengages the phoſphoric acid. If the maſs be now repeatedly waſhed in water, and the lie ſlowly evaporated, the ſulphate of lime, which ſtill adhered, will be gradually expelled, and at laſt phoſphoric acid, in a dry and vitreous form, is obtained.

§ MXXX. Or earth of bones, being perfectly diſſolved in nitric acid, ſulphuric acid, is added by drops till precipitation ceaſes. On ſeparating the ſulphate of lime, we have thus a mixture of phoſphoric and nitric acids, from which the latter may be diſengaged by diſtillation.

§ MXXXI. But, to obtain the phoſphoric acid perfectly free from calcareous earth and phoſphate of lime, it is completely ſaturated with ammoniac; the precipitated calcareous earth is then ſeparated by filtration, and, after the lie is perfectly evaporated, the ammoniac and ſulphate of ammoniac, if any be preſent, are expelled by calcination.

§ MXXXII. Pure phoſphoric acid appears in a vitreous ſtate; but it readily attracts the humidity of the atmoſphere, and becomes a colourleſs and inodorous liquid. It is very fixed in the fire, and fuſes by an intenſe heat into glaſs, ſoluble in water, unleſs it contain calcareous earth or ſulphate of lime, the glaſs, in that caſe, is inſoluble. It produces no effect upon ſilex, but acts upon glaſs.

§ MXXXIII. Phoſphoric acid, ſaturated with pot-aſh, forms a neutral ſalt, viz. phoſphate of pot-aſh, which ſhoots into tetraëdral priſmatic cryſtals with ſimilar extremities. This ſalt remains dry in the atmoſphere; it readily diſſolves in water; and on burning charcoal it ſwells and becomes a vitreous maſs.

§ MXXXIV. Phoſphoric acid, combined with ſoda, forms phoſphate of ſoda, a neutral ſalt, which, eſpecially if ſuperſaturated with ſoda, ſhoots into priſmatic rhomboidal cryſtals, effloreſcent in the atmoſphere, and of a ſaline taſte, ſimilar to that of culinary ſalt. It requires three parts of cold water and one and a half part of boiling water for perfect ſolution. It ſwells on expoſure to the fire, and melts into a vitreous maſs.

§ MXXXV. When ſaturated with ammoniac it conſtitutes the neutral ſalt termed phoſphate of ammoniac, which ſhoots into priſmatic rhomboidal cryſtals, unchangeable in the atmoſphere, of a bitter and cooling taſte, perfectly ſoluble in ſix parts of cold water, and decompoundable in the fire, for the ammoniac eſcapes, and phoſphoric acid remains.

§ MXXXVI. Phoſphate of pot-aſh is decompoſed by quicklime, which forms in all caſes, when completely ſaturated with the phoſphoric acid, a neutral ſalt almoſt inſoluble in water, viz. phoſphate of lime; but this ſalt may be ſuperſaturated by digeſtion in phoſphoric acid, in which caſe it is ſoluble in water and ſhoots into lamellated cryſtals. The mild alkalis decompoſe phoſphate of lime by double affinity. Fire does not change it, and an intenſe heat is requiſite to melt it into glaſs, which is ſomewhat yellow.

§ MXXXVII. Phoſphate of baryt is almoſt inſoluble in water, and, conſequently, uncryſtallizable; in other reſpects it is ſimilar to phoſphate of lime. Phoſphate of magneſia is alſo difficultly ſoluble in water, and the ſolution when evaporated affords generally a gummy maſs only; it rarely forms minute acicular cryſtals, which effloreſce in the atmoſphere. It fuſes into a tranſparent glaſs, when expoſed to fire. Phoſphate of alumine liquefies in the air, and is more eaſily diſſolved in water; its cryſtallization, however, is almoſt ineffectual, and it merely forms a gummy maſs. It equally melts into a tranſparent glaſs on expoſure to the fire.

§ MXXXVIII. The phoſphoric acid precipitates various metals from their ſolutions, forming inſoluble neutral ſalts with them; thus mercury is precipitated from the nitric acid of a red, and ſilver and lead of a white colour.

CXXXII. OF PHOSPHORUS.

§ MXXXIX. The baſis of the phoſphoric acid is a peculiar inflammable body, termed phoſphorus, which has not hitherto been decompounded. To obtain it in a pure ſtate, the phoſphoric acid is decompoſed by means of a body which has a greater affinity with the oxygen than the phoſphorus, for inſtance, carbon. Hence, if pure phoſphoric acid, phoſphate of ſoda, phoſphate of ammoniac, or phoſphate of lead, be mixed with powdered carbon, and diſtilled from a retort with Woulfe's apparatus, phoſphorus will be obtained; for, the oxygen of the phoſphoric acid combines with the carbon, and forms carbonic acid, which is developed at the ſame time.

§ MXL. The moſt convenient method for obtaining phoſphorus is as follows: phoſphoric acid, evaporated to the conſiſtence of ſyrup, is mixed over fire with pulverized carbon, till the maſs becomes dry; it is then kept upon the fire and continually ſtirred till the bottom of the veſſel begins to be red hot. We now introduce the mixture into a porcelain retort with a wide neck, place it into a reverberatory furnace, and apply, for the purpoſe of a receiver, a large retort inverted, ſo that its bottom, in which we previouſly bore a hole, turns upwards. This retort is filled to the curve of the neck with water. If the experiment be made in the large way, we make uſe of a copper receiver of the ſame ſhape.

§ MXLI. The heat applied at firſt ſhould be but moderate, but ſlowly increaſed till the retort becomes red hot. The firſt product is a great quantity of carbonic acid gaz, which frequently contains pruſſic acid gaz, and, if the phoſphoric acid be impure, volatile ſulphureous acid gaz; the next product is hydrogen gaz, which contains already phoſphorus in a ſtate of ſolution. At laſt phoſphorus appears in the form of a butyraceous maſs, which either falls into the water in tears, or, if the fire be not ſufficiently ſtrong, adheres to the neck of the retort. The reſiduum conſiſts of the ſuperabundant coal, and frequently of a ſmall portion of glaſs of phoſphorus in cryſtals.

§ MXLII. To render the phoſphorus, thus obtained, ſtill purer, it is diſſolved in hot water, and preſſed through a piece of leather. This phoſphorus is ſemi-tranſparent, as white as ſnow, and of the conſiſtence of wax; it melts at the temperature of + 36°, and may be obtained in bright foliated cryſtals, when ſlowly cooled. At the temperature of + 83°, it volatilizes in luminous vapours, and at + 232° it begins to boil. But to avoid inflammation theſe experiments ſhould be made in a vacuum.

§ MXLIII. Phoſphorus, on expoſure to the atmoſphere, burns ſlowly, with luminous vapours; and in the end nothing remains but an acidulous liquor, which is the phoſphorous acid. This acid differs principally from the phoſphoric acid in its fetid ſmell, its almoſt perfect volatility, and in its forming with pot-aſh or ſoda a cryſtallizable, and with ammoniac an uncryſtallizable neutral ſalt. If phoſphorus be expoſed to a higher temperature, in contact with the atmoſphere, it burns rapidly with a white flame, and phoſphorous acid remains. The red ſubſtance which is frequently left in the latter caſe, and which, together with pure phoſphorus, is alſo obtained in the diſtillation of phoſphorus, is a true oxide.

§ MXLIV. Though phoſphorus be inſoluble in water, yet it becomes opaque in it; and is partly changed into phoſphoric acid. Spirit of wine only diſſolves it in a ſmall proportion, but changes it into a tranſparent oil, which, by waſhing in water, regains its former ſolidity. But it is perfectly ſoluble in ether, volatile and fixed oils, to which it communicates a luminous property. Phoſphorus decompoſes all acids, and if nitric acid be treatedwith it in fire, it is changed into pure phoſphoric acid.

§ MXLV. The cauſtic alkalis diſſolve it; and if the ſolution be made under water, a conſiderable quantity of hydrogen gaz is developed, which contains phoſphorus in a ſtate of ſolution, and owes its formation to the decompoſition of the water. This phoſphorated hydrogen gaz has a very fetid ſmell, which reſembles that of putrid fiſh; it inflames as ſoon as it comes into contact with atmoſpheric air, andcauſes violent exploſions when mixed with oxygen gaz.

§ MXLVI. Phoſphorus and ſulphur may be combined in any proportion; but this compoſition does not always appear under the ſame form. If equal parts of ſulphur and phoſphorus be combined by a moderate heat, we obtain a maſs which remains fluid at 4° of Reamur, and a compoſition of one part phoſphorus and one half part ſulphur requires no more than 8° to become fluid. But, if two parts of ſulphur be combined with one part of phoſphorus, the mixture remains ſolid even at a temperature of from 12 to 15°. Theſe compoſitions are moreover very inflammable when in contact with atmoſpheric air.

§ MXLVII. Phoſphorus combines in the dry way with all metals and ſemimetals; to this end the glaſs of phoſphorus ſhould be melted with the metals, which are thus deprived of their malleability, and become brittle. All thoſe metallic phoſphorets are decompounded in the fire, when the phoſphorus eſcapes.

§ MXLVIII. Phoſphoret of iron mixed with pure iron renders it cold ſhort (kaltbrüchig). If ſuch iron be diſſolved in acids, the phoſphorus is changed into phoſphoric acid, and remains in combination with the iron in the form of a white powder, which was formerly termed ſyderite, and is a true phoſphate of iron.

§ MXLIX. If a piece of phoſphorus be thrown into a ſolution of gold, ſilver, copper, &c. the metals are precipitated in a metallic ſtate, and the phoſphorus is covered with a brilliant metallic cruſt. In he dry way it reduces arſenic in the ſame manner.

CXXXIII. OF HAIR, FEATHERS, AND SILK.

§ ML. The hair of animals, which, according to their length, ſtrength, &c. are termed hair, briſtles, or wool, differ in their chemical compoſition both from bones and the white and ſoft animal parts: they contain but a ſmall portion of jelly, fat, and lymph, and appear principally compoſed of the fibrous part of muſcles. When boiled in water only an inconſiderable part of them is diſſolved, which is the jelly. The mild alkalis have no action upon them; cauſtic alkalis, on the contrary, diſſolve them completely Acids diſſolve theſe ſubſtances by the aid of heat, which ſolutions are decompoſed by water, the ſubſtances being precipitated in the form of white flakes. They afford by dry diſtillation the general products of animal bodies.

§ MLI. Feathers chemically conſidered differ merely from the ſubſtances above mentioned in containing a ſtill ſmaller proportion of fat and jelly. The quills, however, approach more to the nature of horn, and become harder and more brittle by heat. On account of their jelly they eagerly attract the humidity of the atmoſphere, and are therefore, as well as hair and whalebone, highly uſeful for hygrometers.

§ MLII. Silk, the web of all other caterpillars, and the ſilk of the naker, (barba pinnæ marinæ) are chemically conſidered almoſt the ſame ſubſtance as wool; from which they differ merely becauſe they are leſs ſuſceptible of colours, and on account of ſome peculiar properties when dyed.

CXXXIV. OF SYNOVIA.

§ MLIII. Synovia is a ſemi-tranſparent viſcous humour, of a pale green colour, a faint odour, and ſaline taſte, which changes the juice of violets green, and renders lime-water turbid. Soon after its ſeparation from the joints, it aſſumes a gelatinous conſiſtence, which neither a moderate heat, nor cold, nor expoſure to atmoſpheric air, nor the deprivation of it, can prevent. In a ſhort time, however, it becomes fluid again, depoſits a fibrous ſediment, and at laſt undergoes putrefaction.

§ MLIV. If a ſmall portion of ſynovia be expoſed to a dry atmoſphere, it ſpeedily dries into a ſcaly cruſt, in which we clearly diſtinguiſh two kinds of ſalts; one appears in cubic cryſtals, and the other in an effloreſcent ſtate; the former is culinary ſalt, the latter carbonate of ſoda.

§ MLV. Synovia combines in all proportions with cold water, with which it forms a viſcous liquid.—But, if boiling water be uſed, it coagulates in ſome degree, and forms a milky fluid, which is ſtill adheſive, and depoſits a few coagulated pellicles. Alcohol produces a ſimilar coagulation, without deſtroying entirely its viſcidity.

§ MLVI. Concentrated mineral and vegetable acids precipitate a ſubſtance from it in the form of flocculi, but which is ſoon diſſolved in the liquor. Highly diluted mineral, and eſpecially vegetable acids, for inſtance, vinegar, coagulate ſynovia in the moſt perfect manner, and deprive it of its viſcidity. The liquor becomes again clear, and depoſits a fibrous ſediment.

§ MLVII. The mild alkalis combine very readily with ſynovia, but do not, in other reſpects change it. The cauſtic alkalis ſeem to dilute it; they diſſolve the exſiccated ſynovia, and the fibrous precipitate, (§ MLVI.) in the moſt perfect manner.

§ MLVIII. It affords, by dry diſtillation, firſt, an acidulous phlegm very liable to putrefaction; ſecondly, a volatile alkaline liquid; thirdly, an empyreumatic oil, and mild ammoniac in a dry form. The coal, which remains in the retort, being waſhed, yields common ſalt and carbonate of ſoda, and, after incineration, a ſmall quantity of phoſphate of lime.

§ MLIX. It is obvious from the facts juſt ſtated, that ſynovia conſtitutes a peculiar humour, which contains the albuminous matter of egg or lymph in a twofold ſtate. The firſt is that in which it exiſts in all other animal humours, and in which it is ſeparated by hot water and alcohol, (§ MLV.) But in the ſecond ſtate it is diſengaged only by vegetable and all ſtrongly diluted acids, (§ MLVI.) This latter lymph is diſtinguiſhed from common lymph alſo by the fibrous form which it aſſumes during its coagulation, and becauſe it may be combined with cold water by agitation, from which ſolution it is then precipitated by acids and alcohol in the form of flocculi.

§ MLX. The conſtituent parts of ſynovia are, therefore, first, lymph in a peculiar ſtate; ſecondly, common lymph; thirdly, water; fourthly, culinary ſalt; fifthly, carbonate of ſoda; and ſixthly, phoſphate of lime. According to Mr. Margueron, the proportion of theſe conſtituent parts in 288 grains of the ſynovia of an ox, upon which the preceding experiments were made, is 34 grains of the peculiar lymph; 13 grains of common lymph; 5 grains of culinary ſalt; 2 grains of ſoda; 2 grains of phoſphate of lime; and 232 grains of water.

CXXXV. OF URINE.

§ MLXI. Urine is perhaps of all humours that which differs moſt, not only on account of the difference of the animal, but alſo with regard to the ſtate of health, the nutriment, nay, even the affections of the mind. Phyſicians conſider the urine of the human ſpecies principally in two ſtates; firſt, as emitted immediately after the taking of nouriſhment, which is termed crude urine; ſecondly, when rejected after digeſtion, which is diſtinguiſhed by the name of concocted urine.

§ MLXII. The freſh urine of a perſon in health is of the colour of white wine, and tranſparent; it has a peculiar ſmell, and is ſaline to the taſte. It does not change the colour of ſyrup of violets. Lime-water and the fixed alkalis, on being mixed with it, immediately excite an ammoniacal ſmell. It putrefies very ſoon when left to itſelf, and much ammoniac is developed. It then depoſits a white powder, though obtained from a perſon in health; but, in fevers, the powder is reduced and depoſited much quicker; not unfrequently likewiſe a ſaline ſubſtance is cryſtallized on the ſides of the veſſel.

§ MLXIII. Freſh urine, when diſtilled on a water-bath, affords a nauſeous phlegm, and a reddiſh extract, ſimilar to earth, remains. If this be put into a retort and urged by a ſtronger heat, we obtain a volatile alkaline liquid, termed ſpirit of urine; alſo ammoniac in a dry ſtate, and a very fetid empyreumatic oil, and frequently, if the heat be intenſe, a ſmall portion of phoſphorus; the reſidue is a coal, the aſhes of which contain culinary ſalt, muriate of pot-aſh, phoſphate of ſoda, and calcareous earth.

§ MLXIV. If freſh urine be repeatedly evaporated by a gentle heat, and then expoſed in a cool place, cryſtals, conſiſting of different ſalts, will be formed. Theſe ſalts are chiefly muriate of pot-aſh, muriate of ſoda, and what is diſtinguiſhed by the name of microcoſmic ſalt, which is a mixture of the phoſphates of ammoniac and ſoda. After all the ſalts are thus ſeparated from the urine, there remains a kind of extractive ſubſtance, one part of which is ſoluble in alcohol, and the other in water. The former is of a ſaline nature, and attracts humidity from the atmoſphere, but in other reſpects as yet undetermined.* The latter is probably of a gelatinous nature.†

§ MLXV. The ſediment depoſited by urine when at reſt, eſpecially during putrefaction, and of which the quantity is very conſiderable in ſome diſeaſes, conſiſts of phoſphate of lime and calculus of the bladder.

---

* It affords by diſtillation a ſmall quantity of oil, carbonate of ammoniac equal to more than half its weight, and ſome muriate of ammoniac; the reſidue tinges ſyrup of violets green.—*Vide* ROUELLE.

† It is brown and more eaſily dried than the former ſubſtance, and affords by diſtillation the uſual products of all animal bodies. *Ibid.*

§ MLXVI. The difference between putrid urine and freſh urine is, that the former contains free ammoniac; that its reſiduc, after diſtillation on the water-bath, contains free phoſphoric acid; and that conſequently, when evaporated, it affords leſs microcoſmic ſalt, provided no ammoniac has been added during evaporation.

§ MLXVII. It therefore appears that the true conſtituent parts of urine are water, culinary ſalt, muriate of pot-aſh, phoſphate of ſoda and ammoniac, jelly, the peculiar extractive matter, and calculus of the bladder. A knowledge of theſe conſtituent parts enables us likewiſe to account for the formation of all other ſubſtances obtained during the chemical treatment of urine, and which are mere products.

CXXXVI. OF THE CALCULUS OF THE BLADDER.

§ MLXVIII. The concretions frequently met with in the bladder, the matter which collects near the joints of perſons afflicted with the gout, and the ſediment in urine, are, chemically conſidered, one and the ſame ſubſtance. But, although we may obſerve a remarkable difference in different calculi, eſpecially as to the proportion of their conſtituent parts, yet they generally agree in the following properties.

§ MLXIX. Though the calculus of the bladder be perfectly ſoluble in boiling water, yet the quantity is extremely ſmall, one part of it requiring no leſs than 1000 parts of water for ſolution. Neither ſpirit of wine nor ether have any action upon it.

§ MLXX. The muriatic acid has no action upon the calculus; but concentrated ſulphuric acid, aſſiſted by heat, diſſolves it completely, and with diſengagement of volatile ſpirit of ſulphur. Diluted nitric acid acts upon calculus in the cold, and diſſolves it entirely when aided by heat. This ſolution has an acid taſte, even when perfectly ſaturated with the calculus; its colour is yellow, which becomes red if concentrated by evaporation; and it tinges the ſkin of the colour of cinnabar. Nitrous gaz and carbonic acid gaz are developed during the ſolution, and, by means of the oxalic acid, we are ſometimes enabled to precipitate calcareous earth. When treated with nitric acid recently prepared, the ſolution is at laſt converted into the acid of ſugar.

§ MLXXI. Cauſtic alkalis diſſolve the calculus, and form a ſaponaceous liquid with it; but mild alkalis have no action upon it whatever. Lime-water only diſſolves it in ſmall quantity, and is at the ſame time deprived of its cauſticity.

§ MLXXII. If the calculus of the bladder be diſtilled from a retort, we obtain a conſiderable quantity of inflammable and carbonic acid gaz, a volatile alkaline fluid, and a dry ſalt of a brown colour, which, by re-diſtillation, becomes white, and has then all the properties of an acid. The coal which remains is difficultly incinerated, and contains phoſphate of lime. Some calculi afford likewiſe a ſmall quantity of empyreumatic oil.

§ MLXXIII. From the facts juſt mentioned we may infer that the calculi of the bladder conſiſt for the moſt part of a peculiar acid, termed the lithic acid, combined with animal jelly, and frequently with phoſphate of lime. Some Chemiſts believe this acid to be the ſame as the acid of ſugar.

CXXXVII. OF THE HUMAN FÆCES.

§ MLXXIV. Though one may readily conclude that the fæces or excrements, which, in a ſtate of health, conſiſt ſimply of the parts ſeparated from the aliment unfit for nutrition, ought to vary according to the nature of the food, yet its exact analyſis is ſtill deſirable, and all our knowledge reſpecting this ſubſtance is limited to the following facts: firſt, that it obtains its colour from the bile which it takes up and conveys along; ſecondly, that its fetid ſmell is owing to the incipient putreſaction which it undergoes in its long paſſage through the inteſtines; and, thirdly, that it affords by dry diſtillation the uſual products of all animal ſubſtances.

CXXXVIII. OF SWEAT.

§ MLXXV. The difficulty of obtaining a ſufficient quantity of ſweat has hitherto prevented its more accurate analyſis. It is known however to be alſo very different according to circumſtances. Its taſte is generally ſomewhat ſaline, but its ſmell is either more or leſs aromatic, ammoniacal, or acrid. Its conſiſtence is commonly that of water; not unfrequently alſo it is glutinous, thick, and tenacious, inſomuch that during its exſiccation it leaves a reſidue upon the ſkin. In general it tinges blue vegetable juices red, which is attributed to the preſence of phoſphoric acid; the ſweat of gouty perſons poſſeſſes this property in an eminent degree. Sweat in a few rare caſes has been obſerved to tinge linen and white woollen cloth blue.

CXXXIX. OF THE HUMOUR SECRETED IN DROPSY.

§ MLXXVI. The humour ſecreted in various ſpecies of dropſy and in the milk fever, in different parts of the human body, agrees almoſt entirely with the ſerum of blood. It is uſually ſomewhat yellow, ſcarcely turbid, and ſimilar, even in its external appearance, to ſerum of blood. It has a peculiar ſmell, which, in ſome caſes is apparently acid, for inſtance, in the milk fever; its taſte is ſaline.

§ MLXXVII. When left to itſelf it becomes firſt turbid, and at laſt putrefies. On expoſure to the temperature of boiling water, it coagulates for the moſt part; and poured into hot water it forms a milky fluid, which is incoagulable by nitric acid. It tinges the juice of violets green. It coagulates in all acids, but alkalis ſeem rather to dilute it; and mild alkalis precipitate, ſometimes in the courſe of a few hours, a gelatinous ſubſtance. (§ DCCCCXCVIII.) which is conſidered as a proof of the preſence of pus.

§ MLXXVIII. The white, untranſparent, and ſeemingly unctuous membrane (Pſeudomembrana Ruyſchii) which, in the diſeaſes above-mentioned, frequently accompanies this humour, agrees with the fibrous part of blood, and with its buffy coat. By heat, and on expoſure to the air, it dries into a corneous ſubſtance, but in moiſt air it putrefies very ſpeedily. When triturated with water it forms an imperfect ſolution, from which the mild alkalis precipitate a gelatinous matter.

CXL. OF THE HUMOUR SECRETED BY BLISTERS.

§ MLXXIX. The humour collected by bliſters agrees alſo in its chemical properties with ſerum of blood. It differs from the latter chiefly in its browner colour, and in poſſeſſing the ſmell of the plaſter; no difference has been obſerved between the humour obtained from a perſon in health and that from one in a putrid fever.

§ MLXXX. Perfectly analogous to this humour is that of bliſters, cauſed by muſtard, burning, the ſting of inſects, the bite of ants, and ſome cutaneous diſeaſes.

CXLI. OF THE FORMIC ACID.

§ MLXXXI. It was known already to the antient naturaliſts that ants ejaculate a peculiar fluid, which tinges flowers of a blue colour red, and has an acid taſte. But the exact analyſis of this fluid is due to the moderns, who have found it to be an acid of a peculiar kind, termed the formic acid. It is obtained from the Formica rufa Linn. either by expreſſion, diſtillation, or infuſion in hot-water.

§ MLXXXII. The fluid obtained from ants by expreſſion is not the pure formic acid, for, when at reſt, it depoſits a yellowiſh brown, ceraceous, mucilaginous oil, termed expreſſed oil of ants. If the remaining acid be then diſtilled by a gentle heat, a colourleſs acidulous liquid, which is pure formic acid, will be obtained. On increaſing the heat, this liquid is ſucceeded by an empyreumatic acid, and, laſtly, by an empyreumatic oil. The reſidual coal affords, by incineration, a ſmall quantity of phoſphate of lime.

§ MLXXXIII. Pure formic acid has a peculiar and very penetrating ſmell. It is incapable of cryſtallization. It is perfectly volatile, ſo that when diſtilled, it paſſes into the receiver unaltered. With pot-aſh, ſoda, and ammoniac, it forms deliqueſcent neutral ſalts, which are ſimilar to neutral acetates, and have a bitter taſte. With calcareous and ponderous earths, however, it generates cryſtallizable neutral ſalts.

§ MLXXXIV. When treated with alcohol it forms true formic ether; but if alcohol be diſtilled directly upon ants, on the water-bath, a weak ſpirit of ants, of a ſweetiſh taſte, is obtained, known, in pharmacy, by the name of ſpirit of ants.

§ MLXXXV. Some fat oil of ants is likewiſe obtained if the inſects be boiled in water, and then ſqueezed. But, if ants be diſtilled, we obtain a ſmall quantity of volatile oil, viz. the volatile oil of ants.

CXLII. OF THE BOMBIC ACID.

§ MLXXXVI. When the ſilk-worm enters into the ſtate of chryſalis, its juice contains all the properties of an acid, and this is ſtill obſervable in the chryſalides themſelves, from which it is obtained in the following manner: the living chryſalides are infuſed in alcohol, which is afterwards poured off and ſeparated, by evaporation, from the acid, which thus remains behind. Its properties, however, are as yet but little known. An acid may be obtained, in like manner, from May-bugs.

CXLIII. OF CANTHARIDES.

§ MLXXXVII. Few chemical reſearches have been hitherto made on this ſubject, and it remains ſtill doubtful to which chemical principle of cantharides we ought to attribute the acrimony and medicinal virtue. This principle, however, is not volatile, nor is it diſſipated by exſiccation. It is inſoluble in water, and the inſect, by being boiled in water, is not deprived of its virtue. But this may be extracted by ſpirit of wine, and the tincture, thus formed, poſſeſſes all the properties of cantharides.

§ MLXXXVIII. Cantharides, as well as May-bugs, common flies, and ſome ſpecies of butterflies, afford, by dry diſtillation, beſides the uſual products of animal bodies, a peculiar empyreumatic acid, which, combined with ammoniac, forms a neutral ſalt.

CXLIV. OF CASTOREUM AND MUSK.

§ MLXXXIX. Caſtoreum is a peculiar matter, contained in two proper pouches of the male or female caſtor. It has an acrid, bitter, nauſeous taſte, and a peculiar ſtrong aromatic ſmell. It conſiſts of a reſinous ſubſtance, which may be extracted by alcohol and ether; a gelatinous matter ſoluble in water; and a peculiar ſalt hitherto but ſlightly examined, cryſtallizable by evaporating the water. The cellular membrane which contains the caſtoreum does not differ from that mentioned, (§ MXIX.) Caſtoreum affords, by dry diſtillation, a ſmall quantity of volatile oil and ammoniac. The fat of caſtoreum is diſtinguiſhed from common fat merely on account of the odoriferous matter with which it is impregnated.

§ MXC. Muſk is contained in a proper bag, ſituated near the navel of the male muſk-animal. This ſubſtance is inflammable, unctuous to the touch, of the colour of ruſt, of a bitter taſte, and a ſtrong adheſive ſmell. It agrees, in its chemical properties, with caſtoreum, and conſiſts of reſinous and gelatinous parts. It obtains, by trituration with fixed alkalis, an ammoniacal ſmell.

CXLV. GENERAL CONSIDERATION OF THE PROXIMATE AND REMOTE PRINCIPLES OF ANIMAL BODIES.

§ MXCI. It is obvious, from the analyſes of the animal parts on which we have treated, that the following ſubſtances may be conſidered as the principal components of animal bodies: 1, water; 2, jelly; 3, albuminous matter or lymph; 4, ſaccharine matter; 5, fat; 6, reſin; 7, the fibrous part of blood or muſcles; 8, ſalts; and 9, calcareous earth.

§ MXCII. Animal bodies are, therefore, much more compound than vegetables. Both have ſome parts in common, as water, ſaccharine matter, and lime. Other parts, on the contrary, are peculiar to each; thus plants contain volatile oils and ſome eſſential ſalts, whilſt animals contain albumen, which, in vegetables, is met with in ſmall quantity only. Finally, although ſome of the conſtituent parts of animals and vegetables reſemble each other in ſome degree, yet they appear under circumſtances by which they may be eaſily diſtinguiſhed from one another.

§ MXCIII. Such conſtituent parts are animal jelly, which, though it agrees in many of its properties with vegetable mucilage and gum, is yet ſufficiently diſtinguiſhed from theſe bodies on account of the difficulty with which it dries; the property of attracting humidity from the atmoſphere; its change to a tremulous maſs, and its greater tendency to putrefaction. Thus alſo the fibrous part of muſcles poſſeſſes almoſt all the properties of the gluten of farina, yet it differs from this ſubſtance in its greater tenacity and elaſticity. Moreover, the proportion of this ſubſtance is much greater in animals than that of gluten in vegetables. Laſtly, animal fat and reſin differ from expreſſed oils and vegetable reſins even in many of their external properties.

§ MXCIV. The ſalts of the animal kingdom differ, in like manner, from thoſe of vegetables. Beſides the ſmall quantity of muriatic acid and ſoda found in both kingdoms, and the ſebacic acid, which is much more abundant in animal fat than in expreſſed vegetable oils, the vegetable kingdom is diſtinguiſhed by the oxalic, tartareous, malic, citric, and benzoic acids; and the animal kingdom by the lactic, phoſphoric, lithic, and formic acids, and the baſis of the ſaccharine acid of milk.

§ MXCV. All theſe proximate principles of animals (§ MXCI) may be reſolved into the following remoter principles, viz. oxygen, hydrogen, nitrogen, carbon, phoſphorus, lime, and iron. Theſe are preciſely the ſame in plants, with this difference, that the quantity of phoſphorus and nitrogen in the latter is very ſmall, which bodies, on the contrary, form a conſtant and principal part of animals.

CXLVI. OF THE PUTREFACTION OF ANIMAL SUBSTANCES.

§ MXCVI. All animal parts enter into the ſtate of putrefaction as ſoon as they are dead, or deprived of organic power. Some, it is true, undergo previouſly the acid fermentation, but the duration of it is only momentary. The phenomena which accompany this putrefaction differ not only from thoſe of vegetables, but even according to the circumſtances under which this change of animal bodies takes place.

§ MXCVII. The putrefaction of animal ſubſtances is moſt facilitated, 1, by ſufficient moiſture; 2, acceſs of atmoſpheric air; and, 3, a temperature of about 10 degrees of Reaumur, or ſomewhat more. If any ſoft animal part, for inſtance, a piece of fleſh, begin to putrefy under theſe circumſtances, it becomes paler, ſofter, and begins to loſe its conſiſtence and texture; it then exudes a fluid ſimilar to lymph, and ſmells faint and nauſeous. Soon after it decreaſes in volume, and becomes ſtill leſs conſiſtent; its ſmell is then more acrid and ammoniacal; and in this ſtate it effervefces with acids, and changes the juice of violets green. The ammoniac volatilizes by degrees, and, at the ſame time, that peculiar putrid penetrating gaz is emitted which acts ſo dreadfully and with ſuch violence upon the animal body, and of which neither the cauſe nor the conſtituent parts are perfectly known, though ſome Chemiſts conſider it merely as a mixture of phoſphorated and carbonated hydrogen gaz. This period is of long duration; the putreſcent maſs again ſwells up, and developes a conſiderable quantity of carbonic acid gaz. It is now perfectly diſorganized, and the whole is changed into a ſoft putrid maſs of a brown or green colour, which reſumes its former faint nauſeous ſmell, and dries at laſt into a dark brown friable ſubſtance. The ſhorteſt period in which a ſolid animal ſubſtance putrefies, under the circumſtances above-mentioned, is eſtimated at eighteen months, and the longeſt at three years.

§ MXCVIII. The putrefaction of liquid animal ſubſtances, and of ſolid animal parts in water, proceeds much quicker. Animal bodies putrefy, on the contrary, conſiderably ſlower in cloſed veſſels, as well as in the earth. In the latter caſe, the circumſtances of the putrefaction differ according to the quality of the earth. If the earth be very dry, light, and ſandy, and ſheltered from the air and rain, it imbibes, in a ſhort time, all the liquid parts, ſo as to occaſion a want of that humidity in the animal part required for putrefaction, which is thus not only retarded, but frequently altogether obſtructed. On the contrary, in argillaceous earth, and under the atmoſphere, the putrefaction is promoted by the continual ſupply of moiſture. The earth, in this caſe, abſorbs the ſubſtances recently produced, and becomes black, unctuous, and fit for the growth of vegetables.

§ MXCIX. It has been obſerved, in a few rare inſtances, that, when a great number of carcaſes are buried without any intermediate ſpaces of earth, they do not, in this caſe, undergo a true perfect putrefaction, but are entirely changed, the bones excepted, into a ſubſtance ſimilar to fat, ſoluble in water, analogous in its chemical properties to ſoap, and compoſed of a peculiar kind of fat and ammoniac. The bodies, which would otherwiſe eſcape in the form of gaz, are here arreſted, and the hydrogen, it ſhould ſeem, combines, in ſome meaſure, with nitrogen, and, as uſual, forms ammoniac, and partly with carbon, conſtituting the peculiar oil, which, with ammoniac, produces the ſaponaceous ſubſtance of which we have ſpoken.

§ MC. The putrefaction of animal-ſubſtances is, therefore, perfectly ſimilar to that of plants of the ſecond claſs; nor is there any difference in its theory, (§ DCCCXCI.) except that, on account of the greater quantity of phoſphorus and nitrogen, a greater portion of ammoniac and phoſphorated hydrogen gaz is obtained, and that the ſmell is much ſtronger, and more noxious.

OUTLINE

OF THE

PHLOGISTIC SYSTEM.

§ MCI. Becher was the firſt Chemiſt who adopted a ſeparate principle of inflammability, by which he explained not only the action of fire, and the combuſtion of bodies, but many of the moſt remarkable phenomena in chemiſtry at that time known. He conſidered it as an element, and, like his two others, of the nature of earth, for which reaſon he termed it his *Second* or *Inflammable Earth.*

§ MCII. Stahl determined this notion of the inflammable principle more accurately, and gave it the name of *Phlogiſton.* But he differed from the opinion of his tutor, with reſpect to the nature of this ſubſtance, which he aſſerted to be a ſulphureous principle. According to him it exiſts in all the bodies of the three kingdoms, in a greater or leſs proportion, water, ſimple earths, and ſalts excepted.

§ MCIII. It is phlogiſton alone that conſtitutes the combuſtible part in inflammable bodies, or, in the words of Stahl, "eſt ſolum ad ignis motum accommodatum, creatum et aptum; eſt ignis corporeus, vel ipſa præciſe propria materies ignis." Phlogiſton, nevertheleſs, does not itſelf, without being combined with other bodies, form fire, "ſed avolat et diſſipatur in tenuitate inſenſibili, ſive facit dumtaxat ignem valde expanſum et inconſpicuum, ſcilicet calorem." But, alſo, this volatilization and diſſipation cannot take place without the acceſs of other matter, eſpecially water and air.

§ MCIV. After phlogiſton has combined in a greater or leſs proportion with the other natural bodies, it changes their external, and, chiefly, their chemical properties. Its action is moſt conſpicuous upon metals, ſulphur, colours, and odoriferous ſubſtances.

§ MCV. But, when chemiſtry became enriched with a multitude of new facts, it was found that Stahl's eſtabliſhed theory of phlogiſton could not explain every phenomenon; Chemiſts, therefore, endeavoured to render it more definite, and, at the ſame time, more general in its application. But in theſe definitions we obſerve the utmoſt diſagreement, and almoſt every author differs on this ſubject. By way of example, we will ſtate the following opinions, which are moſt remarkable.

§ MCVI. Baumè believed that phlogiſton conſiſted of the matter of fire, combined with an elementary earth. Macquer conſidered it to be the matter of light in a fixed ſtate. Scheele maintained it was a conſtituent part of the matter of heat, which, he ſaid, conſiſted of phlogiſton and vital air. Scopoli and Volta, to form their phlogiſton, combined carbonic acid and matter of heat. Kirwan and Lametherie believed it to be an element different from the matter of heat, and to conſtitute the baſis of inflammable air. Weſtrumb held it to be a conſtituent part of water, which, in his opinion, is formed by the combination of phlogiſton and vital air. Laſtly, phlogiſton, according to Gren, is compoſed of the matter of light and of the matter of heat. This philoſopher maintains, moreover, the ſingular notion adopted by the antient Chemiſts, that phlogiſton is not only deſtitute of gravity, but that it even poſſeſſes a negative weight, that is, it diminiſhes the abſolute weight of bodies by its combination.

§ MCVII. Since, therefore, the opinions reſpecting the properties and compoſition of phlogiſton differed from each other, it neceſſarily follows, that the theories, and the mode of explaining the nature of chemical phenomena, being founded upon thoſe opinions, were equally different; and accordingly we find that each ſect of phlogiſtic philoſophers had its own theory of chemiſtry. Hence, to give a perfect idea of the doctrine of phlogiſton, it would be neceſſary to enter into the merits of at leaſt ſix or eight hundred different theories; but, as this is by far too extenſive for our plan, we will briefly ſtate the points upon which almoſt all the phlogiſtians agree.

§ MCVIII. All the pure metallic calces are ſimple bodies, which, by combination with phlogiſton, enter into the metallic ſtate. The calcination of metals in the fire happens ſolely in conſequence of the volatilization and combination of phlogiſton with the air, or a part of it, whence the calx of metal remains in a pure ſtate. But, if the calx of a metal be treated in the fire with combuſtible bodies, the calx, in that caſe, combines with the phlogiſton of the combuſtible body, and returns to the ſtate of metal.

§ MCIX. When metals are diſſolved in acids, the acid deprives the metal of its phlogiſton. If a metal be then precipitated from its ſolution by means of a body which contains no phlogiſton, alkaline ſalts for inſtance, in this caſe the metal falls down in the ſtate of calx. But, if the precipitating body can afford its phlogiſton to the metal, a metallic precipitate will be obtained, for inſtance, when one metal is precipitated by another.

§ MCX. The augmentation of abſolute weight, during the calcination of metals, and the loſs of ſuch weight during their reduction, is either not explained at all, or accounted for from the ſpecific levity of the phlogiſton. Some phlogiſtians admit that metals, during their calcination, abſorb vital air, and others believe that the augmentation of weight is owing to the water which ariſes from the combination of vital air and phlogiſton, and adheres to the calx.

§ MCXI. Some of the older phlogiſtians aſſerted that the noble metals were not ſuſceptible of a true calcination, and that the earthy form which they aſſumed was a mere external change. Moſt of the modern phlogiſtians grant, however, that thoſe metals may be calcined, and account for their reduction by fire alone, and without the addition of any combuſtible body, by ſaying, that phlogiſton can penetrate through red hot veſſels, or otherwiſe, from the peculiar idea which they entertain of phlogiſton.

§ MCXII. Acids, according to the phlogiſtic philoſophers, are ſimple bodies. In their pureſt ſtate, and freed from all phlogiſton, they term them *dephlogiſticated acids*; when combined with a greater or leſs quantity of phlogiſton, *phlogiſticated acids*; and, completely ſaturated with phlogiſton, they form various ſubſtances, which no longer poſſeſs acid properties.

§ MCXIII. According to them, the perfect acid of ſulphur, or the ſulphuric acid, is the pureſt; combined with more phlogiſton it forms phlogiſticated acid of ſulphur, or the volatile ſpirit of ſulphur, and when perfectly ſaturated with phlogiſton it conſtitutes ſulphur. If ſulphur be burnt in open veſſels, its phlogiſton combines partly with the air, and is carried off, and phlogiſticated acid of ſulphur remains. If metals be diſſolved in concentrated acid of ſulphur, the phlogiſton of the metal combines with the acid of ſulphur, and comes over as volatile acid of ſulphur, or remains in the ſtate of ſulphur. The formation of inflammable gaz, during the ſolution of metals in diluted acid of ſulphur, can only be explained by a forced and hypothetical mode of reaſoning from the ſingular opinions reſpecting the nature of phlogiſton and of inflammable gaz; nor does the theory of phlogiſton give a ſatisfactory reaſon for the augmentation of weight during the combuſtion of ſulphur.

§ MCXIV. The perfect acid of nitre, or the nitric acid, is the dephlogiſticated acid of nitre of the phlogiſtians, which, combined more or leſs with phlogiſton, forms the phlogiſticated acid of nitre, or the fuming ſpirit of nitre, and ſaturated with phlogiſton the nitrous gaz. If nitrous gaz come, therefore, into contact with vital air, it parts with ſome of its phlogiſton, and returns to the ſtate of phlogiſticated acid of nitre. During the ſolution of metals in this acid, the phlogiſton of the former combines with part of the latter, and paſſes off as nitrous gaz. Upon the ſame principle all combuſtible bodies communicate to the nitric acid ſome of their phlogiſton, and render it phlogiſticated.

§ MCXV. The common or imperfect muriatic acid is the phlogiſticated acid of ſalt of the phlogiſtic philoſophers, which, when deprived of its phlogiſton, becomes dephlogiſticated, that is, oxygenated muriatic acid. Some of thoſe philoſophers, to ſave their theory, ſay, that the oxygenated muriatic acid is a peculiar compound liquid.

§ MCXVI. The phoſphoric acid is a ſimple body which, when combined with phlogiſton, forms volatile acid of phoſphorus, and, ſaturated with it, phoſphorus itſelf. According to ſome phlogiſtians, the phoſphoric air, or phoſphorated hydrogen gaz, conſiſts of phoſphorus, phlogiſton, caloric, and water.

§ MCXVII. Sugar conſiſts of acid of ſugar and phlogiſton. The arſenic acid is arſenic deprived of its phlogiſton. Thus by analogy they conclude about all the other acids, though, with reſpect to the vegetable and animal acids, the opinions of the different ſects of phlogiſtians be very different.

§ MCXVIII. Vital air is, according to ſome, a ſimple body, that is, air in the pureſt ſtate; according to others, it conſiſts of caloric and water. In both caſes, they ſay, that, in combination with phlogiſton, it forms phlogiſticated air, that is, azotic gaz. They aſſert that inflammable air is highly compound, and differs according to its origin. Kirwan believed that it was compoſed of phlogiſton and caloric.

§ MCXIX. Carbon conſiſts of aerial acid, phlogiſton, and the fixed incombuſtible parts. Hence, if carbon be burnt, the phlogiſton and aerial acid eſcape, and the earths, metals, and fixed ſalts remain.

§ MCXX. Phlogiſton forms a principal part of all organized bodies, which are, therefore, combuſtible. Some of them contain it in abundance, as oils and fat. Phlogiſton is the cauſe of the odour and colour of plants, and acts a principal part in the animal economy, ſince by its ſolution in the blood, or its deficiency, it produces various diſeaſes.

§ MCXXI. According to the phlogiſtians, the whole utility of reſpiration conſiſts in its carrying off from the body the ſuperabundant phlogiſton. The blood, during its circulation, becomes impregnated with the ſuperabundant phlogiſton, liberated in conſequence of the different functions of life, and, being charged with it, returns to the lungs. The vital air or oxygen gaz, which is inſpired, now ſeparates this phlogiſton from the blood, and, according to ſome, alſo the carbonic acid, likewiſe produced in the blood. The blood thus purified is then diffuſed by the arteries into the body to attract a new portion of phlogiſton.

§ MCXXII. In a ſimilar manner they endeavoured, in their phlogiſtic ſyſtem, to account for moſt of the other phenomena in chemiſtry, to which the looſe and indefinite theory of phlogiſton afforded great facility. But the futility of moſt of theſe explanations is manifeſt, as ſoon as we inſiſt upon a ſtrict conformity with the eſtabliſhed principles of the mutual action of bodies upon each other, and demand an exact account of the weight and meaſure of the bodies made uſe of in experiments. There are many things in nature which we cannot explain, and which will always remain obſcure. It is therefore unreaſonable to reject a ſyſtem becauſe it is unable to remove the veil which hides the cauſe of many appearances. The antiphlogiſtians do not, indeed, arrogate to themſelves this merit; but their ſyſtem deſerves the preference which is granted to it by almoſt all the naturaliſts of the preſent age, ſince it explains moſt of the phenomena explicitly, uniformly, and with the minuteſt circumſtances; appears more conformable to the ſimple path of nature, and draws all inferences from matters of fact, without requiring the aid of ſubtle arguments.

Nihil eſt in intellectu quod non prius fuerit in ſenſu:

BACO.

DESCRIPTION

OF

WOULFE's APPARATUS

FOR

COMPOUND DISTILLATION.

The ſubſtance which is ſeparated in every diſtillation comes over into the receiver in the form of gaz. Now, if the nature of the gaz be ſuch, that by cooling alone it enter with facility into the liquid ſtate, a common receiver, ſufficiently cooled, may be made uſe of for receiving this product, as, for example, in the preparation of alcohol, diſtilled vinegar, &c. But, if the gazeous fluid cannot, by cooling alone, be condenſed ſo as to become liquid, or if this change proceed very ſlowly, there is no other means of obtaining it in the latter form than to combine it, if poſſible, with a greater or leſs quantity of water. Inſtances of this kind are very frequent, as in the diſtillation of nitric acid, of common and oxygenated muriatic acid, cauſtic ammoniac, &c.

The means of which the ancient Chemiſts availed themſelves to accompliſh this end conſiſted in adding, in the retort, to the mixture to be diſtilled, as much water as was neceſſary to arreſt the gazeous body which had been diſengaged. This water, in conſequence of the application of heat, being changed into vapours, came over in this form into the receiver, together with the other gaz, where it condenſed and maintained the gaz in ſolution. This was the mode of proceeding in the operations above-mentioned; but this method is liable to many objections and inconveniencies, the principal of which we will ſtate.

1. Many aeriform acids, ammoniac, &c. are much more volatile than water, and come over, for this reaſon, in part, much ſooner into the receiver than the water. The firſt portion of thoſe bodies, not being arreſted by the water, is, therefore, loſt. Chemiſts endeavoured to obviate this fault, by making uſe of very large receivers, in which the gaz remained included, till it could be diſſolved in the water as it came over. But even theſe were inſufficient, and required to be tubulated to procure an iſſue for the accumulated gaz, and prevent the breaking of the apparatus. Sometimes, alſo, the experimenter was uſed to introduce a ſmall quantity of water into the receiver, previous to the operation; but, as the gaz only touches the ſurface of the water, its ſolution became extremely tedious.

2. It has been proved that gazeous bodies are diſſolved much more readily and copiouſly in cold than hot water. Now, as the water which comes over during the above proceſs is always hot, it heats the receiver, and, of courſe, remains hot for a long time; this is conſequently a new impediment, and the water cannot, therefore, in this manner, be perfectly ſaturated with the gaz.

3. From what has been obſerved, it follows, that the loſs experienced during theſe operations can be diminiſhed only by an extremely ſlow and careful operation, and that the ſlighteſt inattention may not only ſpoil the whole proceſs, but endanger the life of the operator. But, notwithſtanding the utmoſt precaution and attention, the operator remains expoſed, in a great meaſure, to the noxious and diſagreeable vapours; even the mere effuſion of fuming ſpirit of nitre, and of concentrated muriatic acid, from the enormous receivers, is attended with great inconvenience.

4. If, eſpecially in operations in the great way, any dirt or impurity adhered to the body made uſe of, it was taken up by the water, and came over into the diſtilled liquor, for which reaſon the fuming and concentrated muriatic acid, for inſtance, was never obtained clear.

5. Neither the quantity, nor the degree of concentration of the liquor to be obtained, could be optionally determined, ſince the loſs depended upon a great many circumſtances which the operator could not altogether foreſee nor prevent.

To obviate all theſe inconveniencies, ſeveral Chemiſts propoſed new modes of diſtillation, among whom Hales, and, in later times, Rouelle, have peculiarly diſtinguiſhed themſelves. But none of thoſe methods anſwers the purpoſe ſo well, nor has it been more generally received, than that of Mr. Peter Woulfe, which, with the improvements by Pelletier, I will now undertake to deſcribe.

STRUCTURE OF WOULFE's APPARATUS.

This apparatus, as uſed in chemical or pharmaceutical operations, is always formed of glaſs, and, which is the beſt, of white glaſs. In large manufactories only, it may, according to circumſtances, be partly made of wood, iron, copper, &c.

The peculiar veſſels and inſtruments of which it is compoſed, to adapt it for every operation with which we are acquainted, conſiſt as follows:

1. The *Tubulated Receiver*, or *Balloon* with two necks, (Fig. 5.) This receiver ought to have a ſhort wide neck, proportioned to the beak of the retort which we intend to uſe. It ſhould alſo be rather wider towards the mouth, and ſomewhat conical towards the receiver, that it may be joined the cloſer to the beak of the retort, and be more firmly luted. As moſt of the common receivers are jars, of which the greateſt part of the neck is broken off, they have the fault that their neck is narrow at the mouth, and wider towards the belly. The collateral neck of this receiver ſhould be very round, and ſufficiently long, that a cork of ſome length may exactly fit in it. Moreover, the poſition of this neck ought to be ſuch, that, when the receiver is connected with a retort moderately inclined, it ſtands perpendicularly. (Fig. 1.) The dimenſion of theſe receivers ought to

correſpond with the extent of the proceſs; in chemical or pharmaceutical experiments we have ſeldom occaſion for larger ones than ſuch as hold from 8 to 20 pints. If the receiver be very ſmall, the collateral neck may be omitted; but inſtead of it we ſhould bore a hole, of about 2 lines in diameter, to admit the communicating tube.

2. *Woulfe's bottles.* Theſe are common cylindrical ſhort-necked bottles, furniſhed, beſide the uſual neck in the middle, with one or two collateral necks. (Fig 3 and 4.) At firſt they made uſe alſo of bottles with four necks, but theſe may be diſpenſed with in almoſt all operations, for thoſe with two and three necks, as we ſhall ſee hereafter, anſwer our purpoſe as well. The middle or principal neck of theſe bottles is generally ſomewhat wider than the reſt; but its diameter ſhould never exceed one inch, for otherwiſe the junctures become unneceſſarily large. Moreover, theſe necks ſhould be almoſt cylindrical, very round, and as much as poſſible perpendicular and parallel. The ſize of theſe bottles differs according to the operation; they cannot, however, be much ſmaller than of half a pint, and, even in more extenſive operations, they do not require to be larger than of 12 pints.

3. *The communicating tubes.* Of theſe the experimenter ſhould have ſeveral in ſtore, or he ſhould form them, according to neceſſity, of ſtraight tubes of ſoft glaſs, over a charcoal fire, or by the blowpipe. They appear generally in the ſhape repre-

ſented by Fig. 8, and one of their ends is longer than the other, on account of the height of a Woulfe's bottle; in ſome caſes, however, we make uſe alſo of ſuch as are equal in length. If the operation be moderately great, they are beſt of one line in diameter; but, in greater operations, they may meaſure as much as two lines. In general, it is better to have them too wide than too narrow. The intermediate part between the ends ſhould be ſufficiently long, that the bottles, with which it communicates, as well as the refrigeratory veſſels, may conveniently ſtand near each other. The corners or angles of the communicating tube ſhould not be too ſharp, but ſomewhat round, otherwiſe the tube is liable to break. They may be likewiſe made in the form of a ſemicircle. They are commonly quite ſimple, but in ſome caſes they are furniſhed with a ſhort capillary tube, open at the top. (Fig. 8.) Communicating tubes of this kind are not very eſſential, and require great ſkill in making. To obtain the gaz which is diſengaged in many operations in the gazeous form, we make uſe of a ſimilar tube with one of its ends bent. (Fig. 7.)

4. *The tube of ſafety* is a ſtraight glaſs tube, of about one line in diameter, and 1½ or 2 feet in length.

5. *The adopter* (Fig. 6.) ſerves to combine a retort with one of Woulfe's bottles. (Fig. 2.) We ſhould be furniſhed with ſeveral of different dimen-

ſion, according to the ſize of the different retorts. Smaller ones may be made of the beaks of old retorts.

6. *The refrigeratory veſſels* ſerve to cool the liquids contained in the bottles, by means of ice, ſnow, or cold water continually repleniſhed. For this purpoſe we may uſe ſmall wooden tubs, earthen baſons, &c. But the moſt convenient veſſels are thoſe made of tin, and painted with oil colours; they have a cock or ſyphon near the bottom, by which the melted ice, or the water when it becomes too warm, is drawn off. (Fig. 2.)

OF LUTE.

As the joinings in all operations where Woulfe's apparatus is employed, ſhould be perfectly cloſed, leſt any aeriform body paſs through, the choice of a proper lute is of very great importance. All lutes, it is well known, are divided into two claſſes, into fat and common lutes. Of the former we make uſe of two kinds in Woulfe's apparatus, which are prepared in the following manner.

1. Take very dry rich clay, triturate it in an iron mortar, and form it into a thick paſte by ſucceſſively adding boiled linſeed oil, commonly termed linſeed varniſh. This lute is not expenſive, and of very great ſervice in the diſtillation of acids and of all corroſive bodies, but it cannot be long preſerved, and muſt, therefore, be freſh made every time.

2. Take one pound of pulverized amber, melt it by a gentle fire in an iron veſſel with an iron cover, containing 1½ ounce of turpentine. In the mean time boil on a ſeparate fire one pound of linſeed oil, and pour it, thus hot, and while it is continually ſtirred with an iron ladle, into the melted amber. In this manner you obtain a liquid of the conſiſtence of honey, which conſtitutes the baſis of common amber-varniſh. This liquid is then wrought with good dry clay into a paſte, during which operation a ſmall portion of expreſſed nut-oil may be added by way of dilution, and to prevent drying. This lute is much more expenſive than the former, but preferable in all its properties. It keeps for a very long time, and may be uſed twice or three times.

In the diſtillation of volatile alkali, ether, &c. there is no neceſſity for uſing fat lute, we therefore employ one with much more convenience, which is thus prepared: almonds finely powdered and ſifted, or, which is preferable, flour of linſeed is mixed with good ſtarch, properly boiled, and formed into a hard paſte, which, in the operation, may be ſoftened by ſprinkling water upon it. This lute is very clean, and may be employed to great advantage in all operations where no corroſive bodies are treated; but it can be uſed only once, nor does it keep. It becomes ſtill better and more firm, if a ſmall portion of carpenter's glue be previouſly added to the ſtarch.

The application of the lute, in ſecuring the junctures, is another important point, for with the beſt kind of lute we ſhall not be able to cloſe a joining well, unleſs it be properly applied. But this operation is beſt learned by practical inſtruction and uſe, and the only rule which we can give in this place is, that the glaſs is to be perfectly clean and dry, that the lute muſt be applied in ſmall quantities only, and by degrees; and that the laſt portion is to be properly combined with the portions applied firſt, by kneading.

The communicating tubes are inſerted in the necks of Woulfe's bottles, by means of perforated corks. For this purpoſe a hole is firſt bored through the cork, and filed with a round file till the tube may be firmly fixed in it; the outſide of the cork is then filed with a coarſer file till it fit exactly in the necks of the bottles. The cork ſhould always go quite down into the neck, and not appear above it. Woulfe's bottles and communicating tubes, joined to each other by corks alone, are repreſented by Fig. 2, and thoſe which are luted by Fig. 1. In joining the retort with the balloon, or the adopter, or an adopter with the bottles, lute alone is made uſe of, ſome part of which ſhould be always preſſed between the joinings of the veſſels, for theſe muſt never touch each other.

As the junctures defended either by fat or common lute may be eaſily diſplaced by motion, and as fat lute is liable moreover to become ſoft, and to ſink, when expoſed to heat, it is eſſential, in delicate operations, that the joinings already luted ſhould be further ſecured by wet bladders, or, which is ſtill better, by ſtrips of linen coated with white of egg and lime; theſe, by their compactneſs, do not only tend to connect the joinings more cloſely, but they contribute very much to render the lute coherent and firm. For this purpoſe, take ſtrips of linen not too coarſe, of an inch wide, cut them into pieces as long as the coating of the lute upon the joinings is broad, dip them into freſh white of egg, take them out one after another, and rub them well in with powdered quicklime; this being done, put them tranſverſely upon the joining, and preſs them cloſe and even upon the lute. In this manner the lute is covered with one, two, and, in greater operations, with three or four ſtrips, which are then coated once more with white of egg, and, laſtly, with quicklime.

COMPOSITION OF WOULFE's APPARATUS WHEN THE BODIES THAT COME OVER ARE MERELY GAZEOUS.

If, in a diſtillation, the body, which is ſeparated, either on account of the mutual action of the ſubſtances with which it is in contact, or by the action of heat, come over entirely in the form of gaz ſoluble in water, the apparatus, in order to obtain the gaz combined with water, in a liquid form, is conſtructed in the following manner: The earthen or glaſs retort, on the ſand-bath, water-bath, or the naked fire, is joined by means of the adopter, with the central neck of a Woulfe's bottle with three necks. In one of the collateral necks of this bottle the tube of ſafety is inſerted in ſuch a manner that it nearly touches the bottom. The other collateral neck is connected with a Woulfe's bottle by means of a communicating tube with unequal ends, ſo that the ſhorter end only reaches into the neck of the bottle with three necks, whilſt the other extends almoſt to the bottom of the bottle with two necks; this ſecond bottle is combined, in the ſame manner, by means of the uſual communicating tube with unequal ends, or, which is preferable, by means of the communicating tube with the ſmall capillary tube, with a third bottle with two necks. (Fig. 2.) As much diſtilled water is introduced into the firſt, or the bottle with three necks, previous to its being luted, as to allow the tube of ſafety to be immerſed about half an inch. That quantity of water, which from experience we know to be requiſite for the abſorption of the gaz which comes over, is then diſtributed in equal proportions in the ſecond and third bottle. The tube of ſafety remains open, but the ſhort capillary tube of the ſecond communicating tube is luted in ſuch a manner that it may be opened with facility and ſpeed. The ſecond neck of the third bottle is either left open, or ſlightly ſtopped by a cork.

If a tubulated retort be made uſe of, the whole apparatus is luted, and the ſubſtances to be treated, or at leaſt thoſe which are to facilitate the developement of the gaz, are introduced through the tubulure of the retort. On the contrary, the joinings between the retort, the adopter, and the firſt bottle, remain open till the laſt, but are luted the moment the bodies have been introduced through the neck of the retort.

Now, if in conſequence of the gradual application of heat, the ſubſtances contained in the retort begin to act upon each other, and diſengage the gaz, it mixes at firſt with the common air confined in the retort, the firſt bottle, and the firſt communicating tube, which is thus condenſed, and preſſes upon the whole ſurface of the water contained in the firſt bottle, and upon that of the water in the communicating tube of the ſecond bottle.

But, as the reſiſtance of the water in the ſecond bottle is equal to the preſſure of a column of water whoſe height equals the ſum of the heights of the water in the ſecond and third bottle, and is conſequently much greater than the reſiſtance of the water in the firſt bottle, which at moſt is equal to that of a column of water of one inch high, it follows, that the ſurface of the water in the immerſed end of the communicating tube in the ſecond bottle remains unaltered, till, by the gradually increaſed preſſure, the water in the tube of ſafety has riſen to a height which equals the ſum of the heights of the water in the ſecond and third bottle. If, for inſtance, the water in the ſecond and third bottle be 4 inches high, the water in the tube of ſafety would riſe 8 inches before the gaz could be forced through the orifice of the immerſed end of the firſt communicating tube.

As ſoon as the preſſure of the water in the ſecond bottle is overcome, the gaz penetrates through the water, in the form of bubbles, into the ſecond bottle, and from thence through the ſecond communicating tube into the third bottle. During this tranſition, the gaz is abſorbed by the water, and the circumſtances which promote the abſorption are, 1, the ſtate of compreſſure both of the gaz and water; 2, the minute diviſion of the gaz which paſſes through the water; 3, the cool temperature which is to be maintained in the refrigeratory veſſels in the manner repreſented by the plate; for the caloric which is diſengaged from the gaz, frequently raiſes the water to ebullition.

When the operation is once commenced, the water in the tube preſerves conſtantly the ſame altitude, which is only altered in the following caſes:

1. When the developement of the gaz, by imprudently increaſing the heat, or from other cauſes, takes place with ſuch rapidity, that the gaz cannot paſs with ſufficient ſpeed through the communicating tube, and conſequently accumulates in the firſt bottle. In this caſe the water riſes, and, if the maſs be great, and the tube of ſafety not long enough, all the water in the firſt bottle is forced through the tube of ſafety, and the apparatus is ſpontaneouſly opened. The tube of ſafety, in this caſe, therefore, prevents the apparatus from breaking.

2. When the denſity of the water in the ſecond and third bottle is increaſed by the gaz which it has already imbibed. For this reaſon we ſhould never pour too much water into one bottle, but rather diſtribute it in ſeveral; or the ends of the communicating tubes ſhould not be immerſed ſo low, becauſe in moſt operations the denſity of the liquid is at laſt conſiderably increaſed, and of courſe the reſiſtance becomes greater.

3. As ſoon as the developement of the gaz begins to decreaſe, the water in the tube of ſafety deſcends. This happens either towards the end of the operation, or when the heat is imprudently diminiſhed. If the apparatus be then perfectly cooled, the air in the firſt bottle is condenſed to ſuch a degree that the atmoſpheric air enters the tube of ſafety. If this tube were wanted, the water contained in the ſecond bottle would neceſſarily come over into the firſt. It would be the ſame with the third bottle, if we were not to open the capillary tube of the ſecond communicating tube, and thus cauſe the atmoſpheric air to enter. If the communicating tube be without a capillary tube, the luting of the third bottle muſt be inſtantly opened, and the bottle itſelf removed.

4. The height of the water in the tube of ſafety decreaſes alſo at laſt, in conſequence of the ſecond and third bottle becoming cooler, or when from any other cauſe the abſorption of the gaz is more rapid than its developement.

5. Not unfrequently alſo it happens in the midſt of the operation, that the gaz, inſtead of being developed, is abſorbed for a ſhort time by the maſs contained in the retort, or that the volume of this maſs is otherwiſe ſuddenly diminiſhed, which, in like manner, cauſes the water in the tube of ſafety to fall.

The tube of ſafety, therefore, not only defends the apparatus from breaking, but alſo prevents the fluids in the bottles from mixing. It ſerves moreover as a mean by which we may judge of the progreſs of the operation.

If, during the proceſs, we ſhould obſerve a ſmall quantity of gaz unabſorbed paſs through the open neck of the third bottle, a fourth bottle is immediately to be joined with the third bottle, by means of a communicating tube, in the ſame manner as the third bottle is connected with the ſecond. But on this occaſion we ſhould not forget that the preſſure is increaſed in the firſt bottle, and conſult the tube of ſafety.

When the operation is finiſhed, and the apparatus cooled, we find the water contained in the bottles impregnated with the developed gaz, and more ſo in the firſt bottle than in the laſt. The liquor contained in the firſt bottle is frequently not quite pure, becauſe the ſmall quantity of the body which comes over in the liquid form carries along with it the impurities of the diſtilled ſubſtances; the other liquors are, however, perfectly pure. If the weight of the water poured into each bottle has been accurately determined, we ſhall be able, after the operation is finiſhed, to point out in the moſt preciſe manner, from the increaſe of weight, not only the whole weight of the gaz obtained, but alſo the degree of concentration of the fluids in each bottle. By way of example, we will ſtate the reſult of an operation which has been actually performed:

PREPARATION OF SPIRIT OF CAUSTIC AMMONIAC.

One pound and a half of dry ſal ammonic and $4\frac{1}{2}$ pounds of quicklime were introduced into a glaſs retort in this manner. Half a pound of lime was put at the bottom by itſelf, upon this was thrown a mixture of 3½ pounds lime and 1½ pound ſal ammoniac, and the whole laſtly covered with the remaining half pound of lime. The retort was placed on a ſand-bath and connected with an apparatus of the nature before deſcribed. Diſtillation was now commenced, and continued, by a heat gradually increaſed to the ignition of the retort, till the gaz ceaſed to come over. To immerſe the tube of ſafety, three ounces of diſtilled water were poured into the firſt bottle, and half a pound into the ſecond and third each. The apparatus being opened, the firſt bottle was found to contain 4 ounces 2 drams 40 grains of a foul weak ſpirit of ſal ammoniac; the ſecond bottle 1½ ounce, 28 gr. of the ſtrongeſt and pureſt ſpirit of ſal ammoniac; and in the third bottle, 9½ ounces 3 drams 16 grains of an equally pure but weaker ſpirit.

Bottle.	Water.	Increaſe of gaz.		
No. 1	3 ounces	1 ounce	2 drams	40 grains
2	8 ounces	4 ounces	———	28 grains
3	8 ounces	1 ounce	7 drams	16 grains
	19 ounces	7 ounces	2 drams	24 grains

From this computation it appears therefore, that 1½ pound of ſal ammoniac affords 7 ounces 2 drams 24 grains of pure gazeous ammoniac, which diſſolved in 19 ounces of water, form 29 ounces 2 drams 24 grains of ſpirit of ſal ammoniac, of which the ſmall portion contained in the firſt bottle is weak and impure, and cannot therefore be computed; that contained in the ſecond bottle is very ſtrong, ſince two parts water contain one part gaz; that the third portion is alſo pure, but leſs ſtrong, the proportion of the gaz to the water being about 1 : 5.

COMPOSITION OF WOULFE's APPARATUS WHEN THE BODIES COME OVER BOTH IN THE LIQUID STATE AND IN THE FORM OF GAZ.

If the products which come over in any diſtillation whatever, appear partly in a liquid form, and partly in that of gaz, three different caſes may occur.

1. That the gaz which comes over is ſoluble in water, and may thus combined with it be received ſeparately from the body which comes over in the liquid ſtate.

2. The gaz which comes over, whether it be ſoluble in water or not, may be collected in this ſtate, and at the ſame time the liquid body may be ſeparated without any loſs.

3. If the gaz which comes over be two-fold, and partly ſoluble in water and partly not, the ſoluble part combined with water, the inſoluble part in the form of gaz, and the body in the liquid form, all three may be obtained ſeparately and without any loſs.

In the firſt caſe, the apparatus is diſpoſed as repreſented by Fig. 1, that is, the beak of the retort is inſerted in the tubulated balloon, which is connected by means of a communicating tube, of which the ends are equal, with a Woulfe's bottle with three necks, in ſuch a manner that the ends of the communicating tube only reach into the neck of the balloon and of the bottle. In one of the collateral necks of this bottle we inſert the tube of ſafety; and the third neck is combined with a ſecond bottle, by means of a communicating tube with unequal ends, ſo that the ſhorter end only extends into the neck of the firſt bottle, and the longer end almoſt to the bottom of the ſecond bottle. In ſome caſes, this ſecond bottle may be linked in a ſimilar manner with a third. The balloon is left empty; in the firſt bottle we introduce the water which is required for the immerſion of the tube of ſafety, but in the ſecond and third bottle we pour the water which is to abſorb the gaz.

The body which in the diſtillation comes over in the liquid form collects immediately in the empty balloon, and remains at its bottom; but the gazeous fluids, after having forced the common air out of the apparatus, riſe through the firſt communicating tube into the firſt bottle, where, having produced the neceſſary preſſure in the tube of ſafety, they paſs on through the ſecond communicating tube into the ſecond bottle, to combine with the water which it contains. After the operation is finiſhed, the balloon is found to contain the liquid body which has come over, and the ſecond bottle the gaz abſorbed by the water.

Though in caſe of neceſſity the balloon might be connected directly with the ſecond bottle, in the ſame manner as this bottle is connected with the firſt; yet the intermediate bottle, with the tube of ſafety, is of great uſe, as it enables us to judge of the progreſs of the operation, and prevents the water, in caſe of an abſorption of air in the retort, from paſſing into the balloon, where it would not only mix with the fluid, but might frequently, on account of the great heat excited, produce an exploſion of the balloon, and thus endanger the operator. With reſpect to the other circumſtances and cautions, the ſame obſervations are here applicable which we mentioned before.

This compoſition of Woulfe's apparatus is made uſe of in the diſtillation of ethers, and of edulcorated acids, but eſpecially in the preparation of nitric acid, which, by way of example, we will proceed to deſcribe.

PREPARATION OF NITRIC ACID.

Four pounds of nitre, deprived by fuſion of its water of cryſtallization, were pulverized, and introduced into a glaſs retort; the apparatus was compoſed in the manner deſcribed, and all the joinings, except that between the retort and the balloon, were luted with fat lute and ſtrips of linen. Two pounds of the beſt oil of vitriol (that of Nordhauſen) were then poured through the neck of the retort upon the nitre, the joining was immediately ſecured, and diſtillation commenced on the ſand-bath by a heat at firſt gentle, but gradually increaſed till the retort became red hot. The firſt bottle contained 3 ounces of water for the immerſion of the tube of ſafety, and the ſecond bottle one pint of water. The operation being finiſhed the balloon was found to contain 27 ounces and 2 drams of the moſt concentrated fuming nitric acid; in the firſt bottle 5 ounces 6 drams of green fuming nitric acid; and, in the ſecond bottle, 26 ounces of ſtrong blue nitric acid.

Bottle.	Water.	Increaſe.
Balloon		27 ounces 2 drams
No. 1	3 ounces	2 ounces 6 drams
2	16 ounces	10 ounces
	19 ounces	40 ounces

It thus appears that we have obtained in this operation, beſides the 27 ounces 2 drams of fuming ſpirit of nitre, in which the acid is bound by the water contained in the ſulphuric acid made uſe of, 12 ounces 6 drams of nitrous acid gaz, combined with the 19 ounces of the water employed.

Second Caſe. If, in a diſtillation, where the bodies come over partly in the form of gaz, and partly in the liquid ſtate, we wiſh to obtain the gaz ſeparately from the liquid over water or mercury, the retort is joined, as in the former caſe, with the tubulated balloon, the collateral neck of which is connected by means of a recurved tubulated communicating tube with a bell glaſs* in the hydro or hydrargyropneumatic apparatus. The ſubſtance which comes over in the liquid form, is here, as in the former caſe, collected in the balloon; but the gazeous body paſſes through the communicating tube into the hydro or hydrargyropneumatic apparatus, and riſes into the bell-glaſs filled with water or mercury. By opening the ſhort capillary tube of the communicating tube we ſhall at all events prevent the tranſition of the water or mercury from the bell into the balloon. This compoſition of Woulfe's apparatus is frequently made uſe of in the analyſis of organized ſubſtances by dry diſtillation.

---

* I take it for granted that the reader is acquainted with the common mode of treatment of gazeous bodies. T.

Third Caſe. If we know before-hand that the gazes to be obtained in a diſtillation, beſides the body in the liquid form, are two-fold, and that one is ſoluble in water the other not, the two gazes may be obtained ſeparately. To this end the apparatus is compoſed exactly in the ſame manner as in the firſt caſe; and a ſecond bottle is moreover connected by means of the recurved communicating tube with the hydropneumatic veſſel. The liquid body, in this caſe, as in the two former, comes over directly into the balloon, but the gazeous bodies riſe through the communicating tube into the firſt receiver, and from thence into the ſecond. The ſoluble gaz is here abſorbed by the water, and the inſoluble gaz paſſes through the bent communicating tube into the bell of the tube. The tube of ſafety in the firſt bottle indicates the progreſs of the operation, and prevents the tranſition of the water into the balloon, but the capillary tube of the third communicating tube is of great uſe in caſe the water of the tub ſhould come over into the ſecond bottle.

If of the two the ſoluble gaz be carbonic acid gaz, we uſually apply a ſolution of cauſtic pot-aſh in the ſecond bottle inſtead of pure water, becauſe it abſorbs this gaz more perfectly and with greater ſpeed.

This conſtruction of Woulfe's apparatus is principally made uſe of in the examination of organized ſubſtances by fire. Wood, for inſtance, affords by dry diſtillation, an acidulous phlegm, an empyreumatic oil, inflammable and carbonic acid gaz: To obtain theſe products ſeparately the wood is diſtilled in the apparatus as above mentioned, when the water and oil remain in the balloon, the carbonic acid is abſorbed by the cauſtic alkali, and the hydrogen gaz or inflammable air paſſes over into the bell. Now, if the weight of all theſe bodies be aſcertained, we find that the ſum of the weight of the liquid body, of the gazes, and of the reſidual carbon, is, ſave a very ſmall loſs, equal to the weight of the wood made uſe of.

APPLICATION OF WOULFE's APPARATUS FOR THE IMPREGNATION OF WATER OR ALKALIS WITH CARBONIC ACID.

Several ingenious apparatus had been invented for the impregnation of water with carbonic acid gaz, but moſt of them are very complicated and expenſive. Woulfe's apparatus anſwers this end in a much cheaper and ſimpler way.

For this purpoſe a Woulfe's bottle with two necks is connected with a ſecond bottle alſo with two necks, by means of a communicating tube with unequal ends, in ſuch a manner, that the longer end enters the ſecond bottle. After an optional quantity of pure water has been introduced into this ſecond bottle, it is connected in a ſimilar manner with a third bottle, and this with a fourth. All the joinings having been ſecured by lute of almonds, powdered chalk and highly diluted ſulphuric acid is alternately introduced through the ſecond neck of the firſt bottle, which is cloſed immediately after by means of a cork. The carbonic acid gaz, generated during the ſolution of the chalk in the ſulphuric acid, comes over into the ſecond bottle, and what is here not entirely abſorbed by the water, paſſes on to the third bottle, &c. After the operation has been continued for ſome time, the water in the bottles is found to be highly ſaturated with the carbonic acid. The ſolution of the chalk ſhould be carried on very ſlowly, leſt the violent effervescence, and the great degree of heat, cauſe the ſulphuric acid to go over and mix with the water.

In this manner a ſolution of pot-aſh or ſoda may be completely ſaturated with carbonic acid, and changed into a perfect mild ſtate. With a diluted ſolution of pot-aſh we prepare alſo the acidulous water now ſo famous for diſſolving the ſtone; if the lie be concentrated, very beautiful cryſtals of the neutral carbonic acid ſalt will be formed during the operation. For this reaſon the communicating tubes ſhould be always ſomewhat wider in this operation, that they may not be ſo eaſily obſtructed by the cryſtals.

INDEX.

A.

ACIDS, 138.
—— animal, 140.
—— mineral, 141.
—— oxygenated, 140.
—— vegetable, 140.
Acid, acetic, 874.
—— acetous, 864.
—— aerial, 283.
—— arſenic, 673.
—— benzoic, 781.
—— bombic, 1086.
—— boracic, 266.
—— camphoric, 769.
—— carbonic, 283-288.
—— citric, 785.
—— fluoric, 275.
—— formic, 1081-1085.
—— gallic, 791.
—— lactic, 924.
—— lithic, 1073.
—— malic, 787.
—— molybdic, 693.
—— muriatic, 204.
—— muriatic oxygenated, 213.
Acid, nitric, 165.
—— nitro-muriatic, 226.
—— nitrous, 183.
—— oxalic, 783.
—— oxygenated, 144.
—— phoſphoric, 1029.
—— phoſphorous, 1043.
—— pruſſic, 959.
—— pyro-ligneous, 799.
———— mucous, 818.
———— tartareous, 858.
—— of ſugar, 772.
—— ſaccho-lactic, 922.
—— ſebacic, 1009.
—— ſuccinic, 474.
—— ſulphuric, 415-420.
—— ſulphureous, 428.
—— tartareous, 854.
—— tungſtic, 684.
Acetite of ammoniac, 868.
———— copper, 871.
———— lead, 877.
———— mercury, 880.
———— potaſh, 864.
———— ſoda. 867.
Aethiops, martial, 579.

Aethiops, mineral, 557.
——— per ſe, 535.
Affinity, chemical, 17.
——— compound, 30.
——— divellent, 41.
——— double, 40.
——— quieſcent, 40.
——— ſimple, 30.
Air, fixed, 283.
——— inflammable, 123.
Alchemiſts, their opinion of ſolvents, 28.
Alcohol, 830-852.
Alkaheſt, 186.
Alkali, fixed mineral, 146.
——— aerated fixed mineral, 197.
——— fixed vegetable, 146.
——— aerated fixed vegetable, 190.
Alkalis, 138.
Alum, 388.
——— burnt, 392.
Alumine, 312, 386.
Amalgam, 560.
Amber, 471.
Ambergris, 482-483.
Ammoniac, pure, 236.
Analyſis, ſpurious or complex, 8.
——— true or ſimple, 8.
Antimony, 612.
Aqua fortis, 169.
——— anodyna, 838.
——— regia, 226.
——— vulneraria cum aceto, 882.
Arbor dianae, 562.
Arcanum duplicatum, 241.
Argent haché, 683.
Aroma, 701.
Arſenic, fixed, 676.
——— red, 680.
——— white, 675.
——— yellow, 688.
Aſbeſtos, 365.
Aſhes of plants, 802-804, 811.
Aſphaltum, 467.
Atmoſphere, 88.
Attraction, 13.
——— of compoſition, 17.
Aurum muſivum, 603.
Azot, 97.

B.

Balſams, 764.
——— artificial, 908.
——— Ruland's, of ſulphur, 757.
Baryt, 312-348.
Baſes, acidifiable, 143.
——— of acids, 142.
Bile, 969-975.
Biſmuth, 651.
Bitumen, fluid, 408.
——— ſolid, 408.
Black lead, 594.
Blende, artificial, 649.
——— pech, 696.
Blood, 940-968.
Blue, Pruſſian, 962.
Bodies, combuſtible, 101-408.
——— gazeous, 57.
——— liquid, 57.
——— phoſphoreſcent, 86.
——— ſolid, 57.
Borate of ammoniac, 272.
——— potaſh, 270.
Borax, 259.
——— calcined, 262.
Braſs, 650.
Butter, 915.

Butter of antimony, 632.
——— arſenic, 682.
——— biſmuth, 655.
——— cocoa, 752.
——— tin, 555.
——— wax, 817.
Buttermilk, 919.

C.

Calcination, 101.
Calculi, biliary, 975.
Caloric, 52.
Calorimeter, 78.
Camphor, 767, 769.
Candeſcence, 77.
Cantharides, 1087, 1088.
Carat, 513.
Carbon, 289.
Carbonate of alumine, 398.
——— ammoniac, 238-303.
——— baryt, 361.
——— lime, 344.
——— acidulous of lime, 347.
——— magneſia, 382.
——— potaſh, 290.
——— ſoda, 297.
Cartilages, 1019.
Caſtoreum, 1089.
Chalk, 344.
Chamæleon mineralis, 674.
Charcoal, 805.
Chemiſtry, definition of, 1.
Cinnabar, artificial, 558.
——— of antimony, 632.
Coagulum of blood, 941, 947.
Cobalt, 662.
Coheſion, 14, 15.
Cold, 76.
Combuſtion, 101.
Conductors of heat, 72.
Congelation, 61.
Conſerves, 895, 898.
Copper, 564.
Cream of lime, 320.
——— milk, 915.
——— tartar, 853.
Crocus antimonii, 623.
———martis aperient, 578.
——— aſtringent, 576.
——— metallorum, 623.
Cryſtals, Hierne's, 845.
——— of tartar, 853.

D.

Decoction, 710.
Decompoſition, 4.
—— by ſimple affinity, 39.
—— by double affinity, 40.
Decrepitation, 203.
Diamond, 409.
Ductility, 488.

E.

Earth, 311.
—— abſorbent, 413.
—— of adamantine ſpar, 407.
—— aerated ponderous, 361.
—— argillaceous, 386.
—— elementary or ſimple, 312.
—— mild calcareous, 344.
—— ponderous, 312.
—— ſiliceous, 312, 399.
—— vitrifiable, 399.
Eau de luce, 481.
Efferveſcence, 35.
Eggs, 1014-1418.
Elaeoſaccharum, 892.
Electuary, 907.
Elements, 10-12.
Elixirs, 763.

Emulſion, 758.
Eſſences, 763.
Ether, acetic, 875.
—— muriatic, 848.
—— of nitre, 845.
—— ſebacic, 1011.
—— ſulphur, 840.
Eudiometer, 113.
——— of Fontana, 178.
——— Scheele, 434.
Excrements, 1074.
Extracts, dry, ſoft, ſimple,
—— compound, 723.
Extracts, aqueous or gummy, 719.
Extracts of bile, 970.
——— blood, 942.
——— lead, 876.
——— milk, 913.
——— ſpirituous, 763.

F.

Faeces, 1074.
Farina, 727.
Fat, 1005.
—— of caſtoreum, 1089.
Feathers, 1051.
Fecula, 724.
Fermentation, 826.
——— acid, 859-883.
——— ſpirituous, 827.
Fire, 77.
Flame, 77.
Fleſh, 1023-1026.
Flour, 1027.
Flowers, argentine of antimony, 613.
Flowers of benzoin, 781.
——— biſmuth, 652.
——— ſal ammoniac, 232.
Flowers of martial ſal ammoniac, 590.
Flowers of ſulphur, 413.
——— zinc, 642.
Fluate of ammoniac, 282.
——— lime, 339.
——— potaſh, 280.
——— ſoda, 281.
Fluor mineral, 339.
Fungus philoſophicus, 174.
Fuſion, 59.

G.

Gaz, 62-64.
—— carbonic acid, 285.
—— fluoric acid, 275.
—— hepatic, 433.
—— hydrogen, 123.
—— muriatic acid, 213.
—— nitrogen, 97.
—— nitrous, 169.
—— nitrous acid, 165.
—— oxygen, 97.
—— oxygenated muriatic acid, 204.
—— phoſphorated hydrogen, 1045.
—— ſulphureous acid, 425.
—— ſulphurated hydrogen, 433.
Glaſs, 403.
—— of antimony, 620.
—— of borax, 262.
Gluten of farina, 727.
Gold, 502.
—— fulminating, 507.
Gum, 762.
—— copal, 484.
—— reſin, 765.
Gunpowder, 457.

Gypſum, 325.
——— burnt, 327.
——— ſlaked, 328.
——— ſtriatum, 325.

H.

Hair, 1050.
Heat, abſolute, 78.
—— animal, 104.
—— free, 69.
—— latent, 68.
—— ſenſible, 69.
—— ſpecific, 67.
Hepar of arſenic, 676.
Horns, 1027.
Hydrogen, 123.
Hydromel, 829.

I.

Ice, 13.
Inflammation, 77.
Iron, 595.

J.

Jargon, 405.
Jelly animal, 1020.
Jet, 468.
Juice, gaſtric, 976.

K.

Kermes mineral, 625.

L.

Lapis calaminaris, 650.
—— cauſticus, 230.
Lead, 604.
Ligaments, 1019.
Light, 82-87.
Lime, 312.
—— aerated, 344.
Lime, quick, 315.
—— ſlaked, 318.
Limeſtone, 344.
Liniments, 909.
Liquor, anodyne of Hoffmann, 844.
Liquor, ſuccinated of hartſhotn, 478.
Liquor of Flints, 400.
Lithantraces, 469.
Litharge, 605.
Luna cornea, 526.
Liver of antimony, 621.
——— baryt, 447.

M.

Magiſtery of biſmuth, 654.
——— ſulphur, 446.
Magneſia, 365.
Malleability, 488.
Malta, 466.
Manganeſe, 688.
Manheim gold, 650.
Marble, 344.
Maſſicot, 605.
Matter, ſaccharine of flour, 727.
—— vegeto animal, 727.
Membrane, cellular, 1019.
Menſtruum, 27.
Mercury, 534.
——— calcined, 535.
——— red precipitate of, 543.
—— white precipitate of, 545.
Mercurius coſmeticus, 545.
——— dulcis, 551.
——— vitae, 634.
Metals, 130-486, 501.
——— noble, 497.
Milk, 922-939.

Milk, ſkimmed, 915.
Minerals, 130.
Minium, 605.
Miraculum chemicum, 337.
Mixture, 20.
Mould, vegetable, 886.
Molybdena, 692.
Mucilage, 762.
Muriate of alumine, 397.
—— ammoniac, 231.
—— baryt, 358.
—— lime, 334.
—— magneſia, 377.
—— potaſh, 228.
—— oxygenated of potaſh, 220.
—— of tin, 556.
Muſcles, 1023.
Muſk, 1090.

N.

Naphtha, 463-464.
Nerves, 1019.
Nihil album, 642.
Nickel, 657.
Nitre, 153.
—— calcareous or earthy, 350.
Nitrate of alumine, 396.
—— ammoniac, 193.
—— baryt, 354.
—— lime, 330.
—— magneſia, 373.
—— potaſh, 153.
—— ſilver, 522.
—— ſoda, 190.
Nitrite of pot-aſh, 189.
Nitrogen, 97.

O.

Oil of alum, 416.
—— amber, 475.
—— camphor, 769.
—— empyreumatic, 800.
—— eſſential, 743.
—— etherial, 743.
—— expreſſed, 751.
—— fat, 751.
—— glacial of vitriol, 421.
—— iron, 589.
—— lime, 335.
—— vitriol, 416.
—— volatile, 743.
Orpiment, 680.
Oxidation, 100.
Oxides, 100.
Oxygen, 97.

P.

Petroleum, 465.
Phoſphate of alumine, 1037.
—— ammoniac, 1035.
—— baryt, 1037.
—— lime, 1036.
—— iron, 1048.
—— magneſia, 1037.
—— potaſh, 1033.
—— ſoda, 1034.
Phoſphorus, 1039.
—— Baldwin's, 332.
—— bononian, 449.
—— Canton's, 444.
—— Homberg's, 335.
Pitcoal, 469.
Plaſters, 910.
Platina, 514.
Plumbago, 594.

Plumbum corneum, 604.
Pompholix, 642.
Potaſh, pure or cauſtic, 293.
——— aerated, 290.
——— mild, 290.
——— vitriolated, 241.
Powder of algaroth, 634.
——— fulminating, 454.
Precipitate of metal, 500.
——— purple of Caſſius, 510.
Precipitation, 35.
Prince's metal, 650.
Principle aſtringent of plants, 791.
Principles, firſt, 10.
Pruſſiate of ammoniac, 966.
——— lime, 966.
——— potaſh or ſoda, 961.
Pſeudomembrana Ruyſchii, 1078.
Pulvis Carthuſianorum, 628.
Pus, 992-998.
Putrefaction, animal, 1096.
——— vegetable, 884.
Pyrites, 411.
——— artificial, 592.
Pyrometer, Wedgwoods, 78.

Q.

Quarz, 399.

R.

Radicals of acids, 142.
Reduction of metals, 497.
Regulus of antimony, 612.
Reſins, 763.
Ruſt, 578.

S.

Sal ammoniac, 231.
——— Glauber's fixed, 334.
Sal polychreſt of glazer, 451.
Saliva, 987-991.
Saltpetre, 153.
Salt, bitter, 367.
—— Glauber's ſecret ammoniacal, 254.
—— ſedative, 266.
—— volatile of vitriol, 420.
Salts, 130.
—— acidulous neutral, 152.
Saturation, 24-25.
Selenite, 325.
Semen, 999-1004.
Serpentine, 365.
Serum of blood, 941, 943, 946.
——— milk, 916.
Silex, 312-399.
Silk, 1052.
Silver, 521.
——— fulminating, 524.
Skin, 1019.
Soap, acid, 754.
—— vegetable, 756.
Soda, pure or cauſtic, 301.
—— vitriolated, 248.
Solution, 17.
Solvents, 27.
Soot, 823.
Spar, ponderus, 350.
Spirit, Beguin's fuming, 440.
—— of Libavius, 555.
—— of ſulphur by the bell, 417.
—— volatile of ſulphur, 428.
—— of vitriol, 421.

Steel, 593.
Sugar, 770.
—— of lead, 877.
—— of milk, 920, 923.
Sulphate of alumine, 388.
—— ammoniac, 254.
—— baryt, 350.
—— copper, 566.
—— iron, 581.
—— lead, 607.
—— lime, 325.
—— magneſia, 367.
—— potaſh, 241.
—— acidulous of potaſh, 246.
—— ſoda, 248.
—— acidulous of ſoda, 253.
—— zinc, 645.
Sulphite of potaſh, 247.
Sulphur, 411.
—— golden, of antimony of the firſt precipitation, 625.
—— golden, of antimony of the ſecond and third precipitation, 626.
Sulphurets, 431.
Sulphuret of ammoniac, 440.
—— baryt, 447.
—— copper, 573.
—— lead, 611.
—— lime, 443.
—— magneſia, 450.
—— potaſh and ſoda, 432.
—— ſilver, 531.
Sweat, 1075.
Synovia, 1053.
Syntheſis, 4.

T.

Tables of affinity, 37.
Tartar, 853.
—— emetic, 640.
—— vitriolated, 241.
Tears, 980-984.
Teleſcopes, achromatic, 606.
Temperature, 70.
Tempering of iron, 577.
Tenacity, 488.
Tendons, 1019.
Terra circonia, 405.
Thermometer, 70-78.
Tin, 596.
Tinctures, 763.
Tincture of amber, 472.
—— Stahl's alkaline of iron, 586.
—— ſimple or tartarized 624.
Tomback, 650.
Tungſten, 685.
Turbith mineral, 538.

U.

Uranite, 696.
Urin, 1061-1067.

V.

Verdegris, 870.
distilled, 871.
Vinegar, 861.
diſtilled, 863.
of milk, 924.
radical, 873.

Vitriol of copper, 566.
——— iron, 581.
——— zinc, 645.

W.

Water, 114.
——— acidulous mineral, 284.
——— chalybeate, 591.
——— lime, 319.
——— phagedenic, 550.
Water, ſimple diſtilled, 116.
Wax, 760.
——— virgin, 760.
Wolfram, 685.
Wool. 1050.

Z.

Zaffre, 663.
Zinc, 641.

EXPLANATION OF THE PLATE.

Fig. 1. Woulfe's apparatus with luted junctures, for the reception of gazeous and liquid bodies.

Fig. 2. Woulfe's apparatus for the diſtillation of ſuch bodies as come over in the form of gaz only, with refrigeratory veſſels, and junctures not luted.

Fig. 3. A Woulfe's bottle with 3 necks.

Fig. 4. A Woulfe's bottle with 2 necks.

Fig. 5. The balloon.

Fig. 6. The adopter.

Fig. 7. A communicating tube with a ſhort capillary tube, and one of its ends curved.

Fig. 8. A communicating tube with a capillary tube, and unequal ends.

Fig. 1.

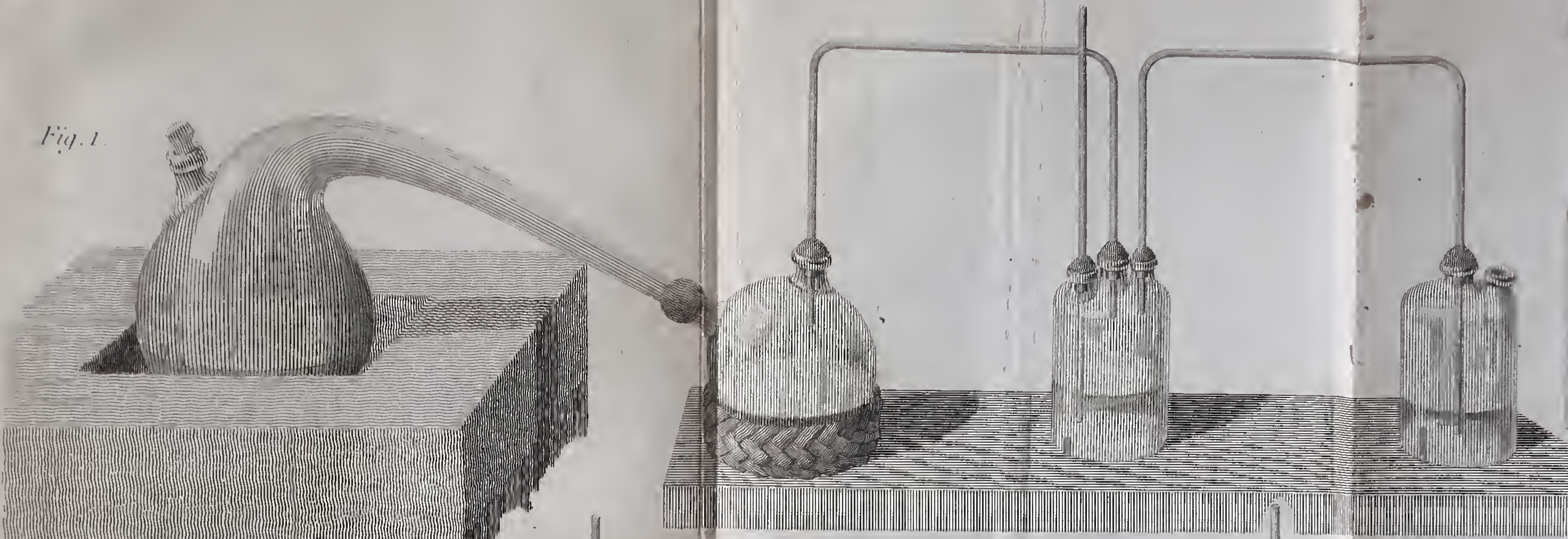


Fig. 6.

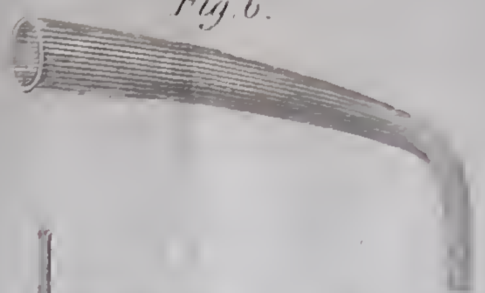


Fig. 7.

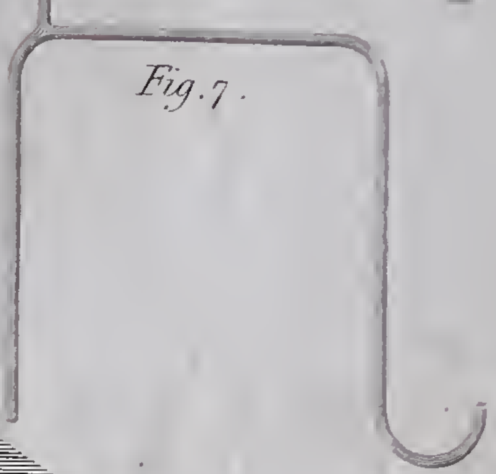


Fig. 2.

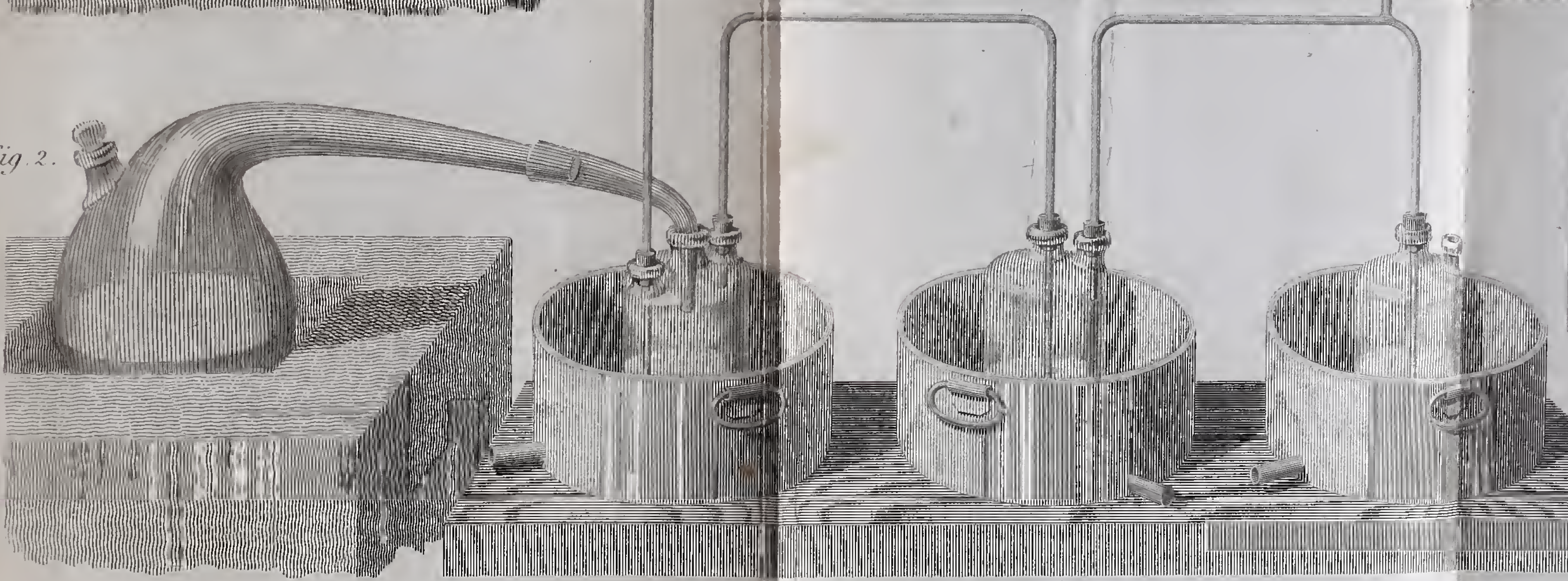


Fig. 8.

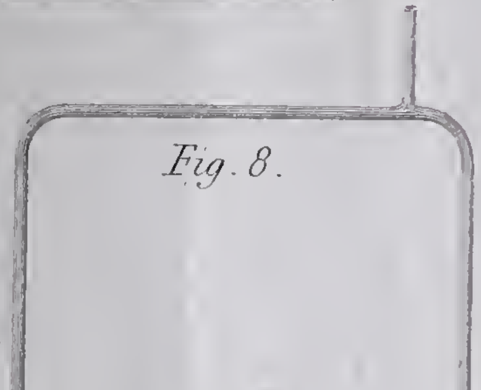


Fig. 3.

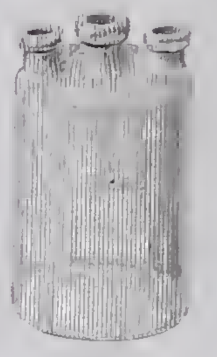


Fig. 5.

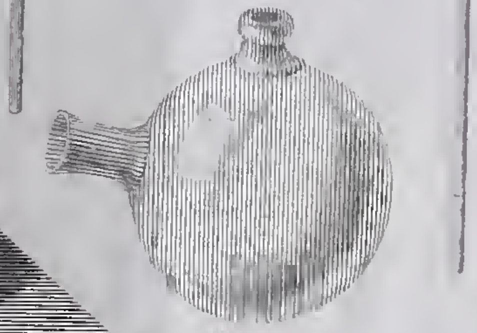
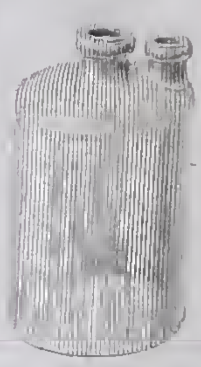


Fig. 4.



Lowry sculp.t